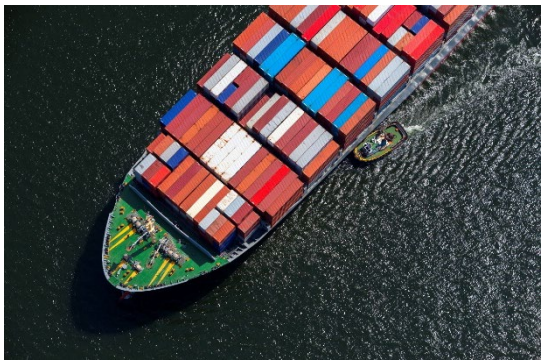
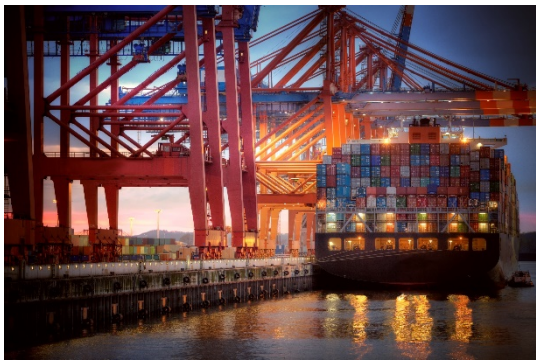
PORT HOUSTON
CLEAN AIR STRATEGY PLAN

2021 Update Version 20211220

PORT HOUSTON
THE INTERNATIONAL PORT OF TEXAS℠

111 East Loop North, Houston, Texas 77029

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ACKNOWLEDGEMENTS

The following companies assisted with development of this this report:

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ACRONYMS AND ABBREVIATIONS

AESS	Automatic Engine Stop Start
BBP	Buffalo Bayou Partnership
BMP	Best Management Practices
CAP	Climate Action Plan
CASP	Clean Air Strategy Plan
CHE	cargo handling equipment
DERA/TERP	Diesel Emissions Reduction Act/Texas Emissions Reduction Plan
DPM	diesel particulate matter
U.S. EPA	United States Environmental Protection Agency
GHG	greenhouse gas
GMEI	Goods Movement Emissions Inventory
HDDV	heavy-duty diesel vehicle
HGB	Houston-Galveston-Brazoria ozone nonattainment area
hrs	hours
HV	harbor vessels
IEA	International Energy Agency
M/S/W	minority/small/women
MM	million
NAAQS	National Ambient Air Quality Standards
NO_x	nitrogen oxide
OGV	ocean-going vessel
Op. Hrs	operating hours
PM	particulate matter
PM2.5	particulate matter less than 2.5 microns in diameter
PHA	Port of Houston Authority
PTRA	Port Terminal Railroad Association
PV	Photovoltaic solar panel
SAP	Sustainability Action Plan
TCEQ	Texas Commission on Environmental Quality
TEU	twenty-foot equivalent unit
yr	year

Executive Summary

Port Houston's Strategic Goal of Stewardship includes striving for improvement in air quality. This Clean Air Strategy Plan (CASP), along with the related Goods Movement Emissions Inventory (GMEI), outlines meaningful goals and strategies for reducing emissions and achieving cleaner air:

CASP Goals

- *Reduce emissions* of measured pollutants as much as practicable including further reductions of NOx emissions and PM2.5 emissions by 4% and 9%, respectively, from 2019 GMEI levels, with stretch targets of 25% and 75% below 2007 levels leveraging additional supporting reductions from port operators and industry
- *Promote technology adoption* for emissions reduction across the greater port area including improvements in infrastructure, alternative fuels and energy sourcing, next-generation equipment, and clean energy supporting local and global air quality
- *Improve the dialogue* for addressing upstream and underlying causal factors in air pollution and air quality, including continuing collaboration with industry, community, federal, state and local agencies, and air quality advocates

CASP Strategies

- *Upgrade Equipment and Technology* to reduce emissions
- *Implement Operational and Technological Efficiencies* to reduce road, rail and vessel traffic delays and improve operations, gaining more productivity per unit of energy
- *Promote partnering and collaborative alignment with stakeholders* to address airshed-wide multi-jurisdictional challenges, and identify practical solutions and projects that improve types and uses of energy and reduce or eliminate air pollutants

Actions and Results

This 2021 CASP Update builds on similar goals and strategies from the prior version published in 2011. Port Houston is delivering by executing these strategies, for example with cleaner yard mules and hybrid electric cranes, improving facilities for faster cargo velocity and lower truck and vessel residence and idling times, DERA partnerships for improving equipment owned by others, partnerships with others for vessel transit efficiencies, proactive focus on bringing in the highest value and cleanest equipment for the Houston Ship Channel Improvements known as Project 11, and numerous opportunities and initiatives related to air quality and clean energy which are articulated in Port Houston's separate Sustainability Action Plan and ES^{2}G reports.

So far, Port Houston's Clean Air strategies have been working. The latest updated GMEI estimates that between 2013 and 2019, pollutant levels from cargo handling equipment were reduced 46% to 74% across seven measured categories. Including related ocean and harbor vessels, heavy duty trucks and rail, emissions were reduced from 14% to 93%. In fact, these brought NOx and PM2.5

to at or below those of 2007. Harbor and ocean vessels related to private facilities reduced emissions in some categories, but others will require more work.

The Need for More

Despite these substantial improvements, it is clear from stakeholders' and from Port Houston's own goals, that the work of improving environmental quality is never done. The 2021 CASP Update analyzes port related source emissions and outlines their emission reduction potential. This update also takes a more strategic holistic view on emissions from sources across the Greater Port of Houston; considerably more emissions reductions may be achieved if additional tactics and third-party partnerships are successfully implemented.

For example, Port Houston has developed a broad Sustainability Action Plan which extends efforts beyond the facilities to the greater port region. Port Houston aims to lead, partner with others, or support 27 opportunities to promote sustainability in the areas of Emissions Reduction, Clean Energy, Circularity, Community Strengthening and Transparency.

Many in the stakeholder community look to Port Houston to address an increasingly wide arena of air quality issues, even beyond those of the public port facilities and Port Houston's authority. Stakeholder concerns extend to communities impacted by emissions and air quality in the greater port region and include promoting improved social and environmental justice through such plans as this one. Just as these concerns do not stop at a specific facility or fence line, the strategies of this CASP also extend importantly to collaboration and partnering to achieve shared goals.

Beyond maritime vessels and cargo related vehicles, other sources in the Greater Port area and across the state contribute to challenges faced by local, regional and state-wide airsheds and their related communities as well as global climate change. These sources include the manufacturing industry, related road and rail traffic, marine activity, and population. Improving air quality in the shadow of the Houston Ship Channel, and improving social and environmental justice related to that, requires all sources and stakeholders to actively take part. Thus, while Port Houston is applying the CASP strategies to its own assets and jurisdiction, we need also to partner and collaborate with others to measurably address these issues.

CASP Tactics

Goals and Strategies require specific measurable and trackable tactics to ensure results are achieved. The list below summarizes 16 tactics specifically aimed at CASP Goals of reducing emissions, promoting technology adoption, and improving dialogue, and supporting CASP Strategies of upgrading equipment, process improvements, and collaborative partnerships.

1. Promote Heavy Duty Truck population to newest emissions standards and support new fuels and technology adoption for lower emissions drayage trucks
2. Replace Port Houston Owned Tier 0 and Tier 1 Cargo Handling Equipment with Tier 4
3. Encourage PTRA and Class 1 Railroads to replace and upgrade locomotives
4. Support Harbor Vessel Tug and Tow operators to continue upgrading fleets

5. Maintain industry leading truck turn times and minimal idling by improving terminal gate capacity, cargo position detection systems and truck entry and exit processing technologies
6. Explore opportunities to move container cargo increasingly to rail and other alternative transport modes / intelligent transportation systems
7. Coordinate Partnerships for At-Berth Ship Emissions Reductions
8. Optimize application of clean technology in dredging operations including Project 11
9. Reduce Emissions from Idling Vehicles
10. Develop Grant Programs to Pursue State and Federal Funding to Reduce Mobile Source Emissions
11. Promote freight mobility projects which improve road and rail traffic conditions, and invest in related projects where connected to port properties
12. Support area-wide vessel scheduling optimization
13. Promote development of alternative fuel production and distribution infrastructure for vessels and trucks, and carbon capture and supporting infrastructure in the Port area
14. Align emissions reduction goals with suppliers, operators and other parties' sustainability goals including partnerships and application of clean technology
15. Advocate for local, state and federal policies which support emissions reduction
16. Develop and Implement the Sustainability Action Plan

Our Work Ahead

Looking forward, fully implementing the CASP and positively impacting air quality in the region is an ongoing journey, which requires alignment with industry, NGO's, environmental and community advocates, and regulators, since Port Houston does not oversee the entire regional airshed, nor have the authority to mandate emission reductions for others.

This update builds on decades of prior work as well as recent dialogue with a broad spectrum of port area stakeholders. Prior plans like the 2011 CASP; the 2007, 2013, and 2019 GMEI reports; the 2021 Sustainability Action Plan and 2021 ES^{2}G Report all play a part in defining measurable ideas, guidance, and actions to improve overall air quality for surrounding communities.

Port Houston has fully funded its role in the CASP, including capital investments for equipment and infrastructure, in-kind resources and staff time working with partners and advocates, grant applications for the Port and on behalf of third parties, and all of its opportunities identified in the Sustainability Action Plan and in the ES^{2}G Report.

Balance of this CASP Document

This document provides additional detail on these strategies and tactics to pursue emission reductions over a 5-year period from 2022 to 2026. The approach, definitions, potential improvements, management discussion and multiple appendices including a seaports best management practices (BMP) review are included. Comments are always welcome and can be addressed to the Port via www.porthouston.com.

Section 1. Clean Air Strategy Plan

The *Port Houston 2021 CASP Update* seeks to outline meaningful emission reduction strategies by leveraging industry Best Management Practices (BMPs), incorporating port-specific data, and partnerships to reduce emissions and to strengthen Port Houston's role as an environmental leader for the region.

The emission reduction strategies and tactics identified in this CASP will require collaboration with industry, non-governmental organizations, and regulators to be realized. Port Houston does not control each emission source described in the CASP and does not have the authority to mandate emission reductions for private fleets. Port Houston has prepared the CASP to lead and influence the adoption of the strategies and tactics herein.

Air Pollutants Targeted in the CASP

The Houston region is nonattainment for ozone. Nitrogen oxides (NOx), which is the common term to describe the nitrogen compounds (nitrogen dioxides and nitric oxides) are integral to ozone formation. In the maritime sector, NOx is a prevalent pollutant due to the extensive use of diesel engines. The reduction of NOx emissions will help reduce ozone formation in the Houston area and will benefit public health.

Fine particulate matter, also known as PM2.5 refers to tiny particles or droplets in the air that are two- and one-half microns or less in width. PM2.5 is also a prevalent pollutant in the maritime sector due to the many diesel engines that are used. Although the Houston area is in attainment for the PM2.5 air quality standard, it is important to reduce these emissions due to ability of PM2.5 to travel deeply into the respiratory tract and cause detrimental health effects.

2021 Clean Air Strategy Plan Update Objectives

The objectives for the *2021 CASP Update* remain the same as the original *2011 CASP*. This CASP benefits Port Houston, the Houston-Galveston-Brazoria ozone nonattainment area, and assists the State of Texas and the U.S. EPA in reducing the harmful health effects of ground-level ozone and other toxic air pollutants. The *2021 CASP* will help identify emission reduction goals in line with the Port Houston's prioritization of sustainability efforts.

These objectives are as follows:

1. **Benefit the Houston Region through Clean Air and Economic Development**
   - Seek cost-effective and commercially viable emission-reduction strategies
   - Research BMPs and proven technologies for cost-effective emission-reduction measures
   - Develop policies and procedures to help minimize emissions from goods movement

2. **Produce a Plan to Reduce Emissions from the Maritime Industry and Transportation and Port Related Businesses**

- Encourage consensus for national and international clean air standards and regulations
- Provide support for initiatives
- Create a forum for maritime- and port-related industries to discuss the latest challenges and achievements in emission-reduction practices and technologies

3. Facilitate and Encourage Maritime-related Businesses to Reduce Emissions

- Identify and promote funding opportunities for the implementation of clean air strategies
- Build public/private partnerships
- Support implementation projects with economies of scale
- Develop a clearinghouse for sharing updates in technology and in policy
- Facilitate education environmental training/seminars
- Implement a recognition and incentive program

4. Inform Regulatory Entities About the Maritime and Port Industry

- Educate government agencies on maritime- and port-related business practices
- Engage government entities in port- and maritime-industry concerns

Air Quality Pollutants

The *2021 CASP Update* targets NOx emissions reductions due to Port Houston's location in an ozone nonattainment area and PM2.5 emissions reduction due to its affects to public health. Although the CASP is focused on NOx and PM2.5, other air quality pollutants measured in the *2019 GMEI* will likely be reduced as well. By consistently monitoring air quality pollutants with periodic GMEIs, Port Houston is able to track and measure progress made towards the emission reduction goals in this CASP. Refer to **Appendix A** for descriptions of the air quality pollutants measured in the *GMEI*.

Emission Source Categories

Port Houston operations facilitate the intermodal movement of goods through the use of heavy-duty diesel vehicles (HDDVs), cargo handling equipment (CHE), locomotives, harbor vessels (HVs), and ocean-going vessels (OGVs). The emission source categories are defined in **Appendix B.**

Emission Data Sources

The *2021 CASP Update* was developed to build on the foundation of the emission reduction work preceding it including underlying data from the *2013 GMEI* and the recent *2019 GMEI*. The GMEI estimates the emissions from the same mobile source categories as the *CASP* (HDDVs, CHE, locomotives, HVs, and OGVs).

Geographic Boundary

In an effort to consistently evaluate emission reductions, the geographic boundary of the *2021 CASP Update* mirrors that of the *2013 GMEI* and *2019 GMEI*. This continuity is intended to

support future evaluation and reporting of emission reductions. The geographic boundary includes Port Houston-owned terminals operated by Port Houston or its tenants.

It is important to note the distinction between Port Houston-owned terminals and the greater Port of Houston. The greater Port of Houston spans the upper 25 miles of the Houston Ship Channel and includes a number of private terminals and Port Houston terminals. **Appendix C** documents Port Houston-owned properties along the Houston Ship Channel.

Section 2. **Approach**

Port Houston is committed to reducing emissions from the fleet it owns and operates and seeks to leverage its position as an environmental leader to influence customers, tenants, and supporting industries to pursue the emission reduction strategies and tactics identified in the *2021 CASP Update*. The following approach was established to ensure that an appropriate range of information was considered when developing emission reduction strategies and tactics as well as evaluating potential emission reductions for the *2021 CASP Update*.

Step 1 — Industry Best Management Practice Review

A detailed review of clean air strategy BMPs at 10 United States seaports was conducted as the first step in the *2021 CASP Update*. The BMP review assessed air quality initiatives at seaports of a similar size and with similar operations as Port Houston. Geographic location, regulatory requirements, infrastructure, operations, and other business drivers have significant influence on how and where air quality initiatives have been successfully implemented. These items vary widely from port to port. For example, regulatory and legislative requirements have played a significant role in the adoption of BMPs on both the west coast and on the east coast. These drivers have contributed to the success of emission reduction strategies in these regions. **Appendix D** provides a summary of the air quality initiatives reviewed as part of the BMP review.

Step 2 — Establish Emission Source Baseline Using the Latest Emission Inventory

The 2013 GMEI was initially used to establish an emissions baseline for the 2021 CASP Update. However, the recently completed 2019 GMEI will provide the opportunity to discuss changes in emissions between 2013 and 2019 and to set emission reduction goals.

Step 3 — Analyze Emission Reduction Potential and Establish Emission Reduction Strategies

Understanding the emission reduction potential of each source category enables the development of attainable data-driven emission reduction strategies and tactics. Section 3 presents a brief analysis of the changes in emissions between 2013 and 2019 and sets a new 2019 baseline emissions for each source category. Following the analysis, emission reduction strategies, and tactics are identified in Section 4. The strategies are designed to help evaluate the emission reduction potential while maintaining economic competitiveness within the industry. Evaluations of emission reduction potential are based on what has already been accomplished between 2013 and 2019, and the viability of proven emission reduction strategies and tactics. Port Houston will work to reduce emissions from the sources it controls and work with industry partners to influence the adoption of these strategies and tactics for the source it does not control.

Step 4 — Evaluation and Reporting

Evaluating progress and reporting results to stakeholders is a critical component of the *2021 CASP Update*. Evaluating progress requires identifying key performance indicators and clear methods for collecting data. Section 6 outlines recommendations for establishing key performance indicators and methods for data collection.

Section 3. Emission Source Category Analysis

Port Houston has made significant progress in reducing mobile source emissions since the *2013 GMEI*. Progress includes the purchase of electric and hybrid CHE and Tier 4 vehicles; implementation of initiatives to reduce idling and encourage the purchasing of hybrid CHE; providing state and federal grant support for stakeholders; and active participation in working groups focused on emission reductions.

Port Houston has prioritized efforts to reduce NOx and PM2.5 emissions associated with conventional diesel fueled engines. This is due to the U.S. EPA 2008 and 2015 8-hour ozone nonattainment status in the Houston region and the documented human health risk associated with PM2.5. Diesel engine combustion is a primary source for both NOx and PM2.5 emissions. Diesel engines power most heavy-duty equipment and most on and off-road vehicles in the goods movement industry. Focusing on the reduction of these pollutants will support the region's efforts to move toward attainment of the U.S. EPA 8-hour ozone National Ambient Air Quality Standards.

Mobile source emissions have been categorized into five categories. These categories are consistent with both the *2013 GMEI* and *2019 GMEI* along with the industry BMPs for evaluating mobile source emissions. Between 2013 and 2019, Port Houston terminals saw significant growth in cargo volume. For Port Houston facilities alone, cargo throughput increased by 8% in short tons and 53% in container twenty-foot equivalent unit (TEU) throughput over the period. Despite the increase in cargo volume, the overall emissions of NOx and PM2.5 pollutants were 14% and 62% lower for Port Houston emissions, respectively, primarily due to fleet turnover and the use of lower sulfur content fuel by OGVs in 2019 as compared to 2013. **Table 1** presents the total net change in Port Houston emissions for all source categories in 2019 compared to 2013.

TABLE 1: 2013-2019 PORT HOUSTON EMISSIONS COMPARISON

Year	NOx tons/year	PM2.5 tons/year
2019	6,967	182
2013	8,145	477
Change	-1,178	-295
Change (%)	-14%	-62%

The following pie chart analysis starts at the highest level with total emissions. Total emissions include both Port Houston owned equipment and privately owned equipment. **Figure 1** summarizes total NOx emissions by source category and **Figure 2** summarizes total PM2.5 emissions by source category for years 2013 and 2019. As can be seen by the pie charts, the percentage contribution by each source has changed in amount and in the order of ranking from largest to smallest. Explanation of these changes can be found in the 2019 GMEI.

FIGURE 1 TOTAL PORT HOUSTON NOX EMISSIONS (TONS/YEAR)

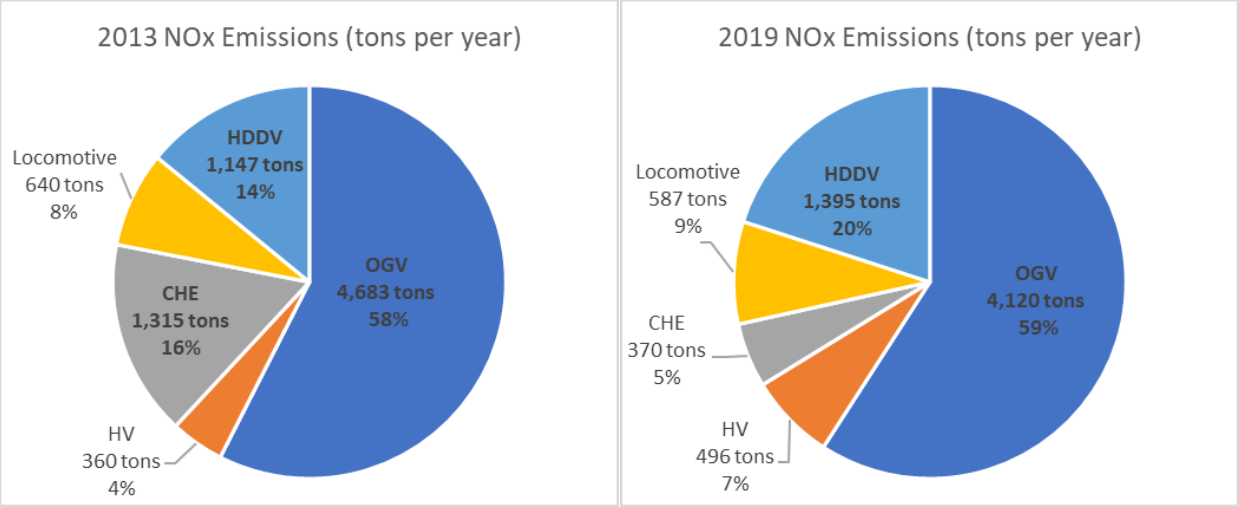
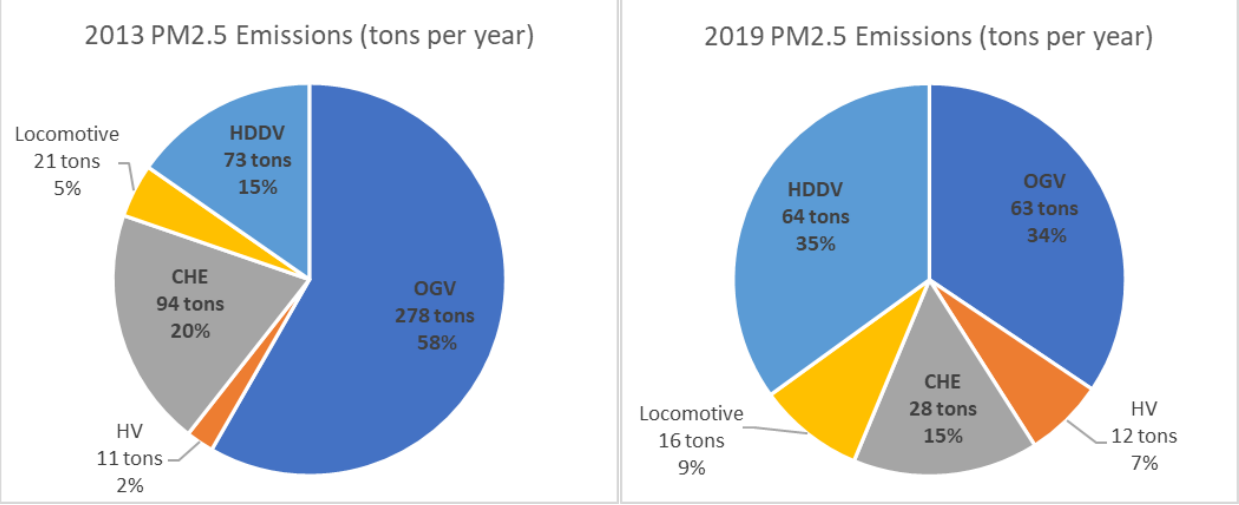


FIGURE 2 TOTAL PORT HOUSTON PM2.5 EMISSIONS (TONS/YEAR)



The following paragraphs provide a high-level analysis of the mobile source category emissions at Port Houston in 2019.

Ocean-going Vessels

OGVs represent the largest source of emissions at Port Houston in 2019. OGVs contributed more than 50% of the total NOx emissions *and almost tied for the largest source of the total PM2.5 emissions,* as shown on **Figure 1** and **Figure 2**. Also shown on **Figures 1** and **2** is that OGV emissions were 12% lower for NOx and 77% lower for PM2.5 in 2019 compared to 2013, These emission reductions at Port Houston terminals are significant but they should be put into context of the OGV emissions for the overall Port of Houston area as shown on **Figures 3** and **4**. Port Houston associated OGV emissions are only 34% of the NOx emissions and 28% of the PM2.5

emissions for the Port of Houston in 2019. This is a change from 2013 when Port Houston associated OGV emissions were 54% of the NOx emissions and 51% of the PM2.5 emissions. The lack of authority over OGVs that call on Port Houston and the Port of Houston, in addition to the immense cost and long useful life of OGVs, present substantial challenges to reduce emissions in this source category. At-berth shore power, and emissions capture and control strategies have proven effective at other seaports in addressing at-berth emissions from OGVs and present a viable option for Port Houston to reduce emissions in this source category. Shore power can significantly reduce emissions from ships at berth while plugged into the electrical grid instead of running auxiliary engines. Capture and control systems attach to vessels' exhaust stacks to capture emissions and route them to an emissions control unit where they are filtered and treated. Each of these emission reduction options is discussed in Section 4.

FIGURE 3 PORT HOUSTON ASSOCIATED OGV NOX EMISSIONS (TONS/YEAR)

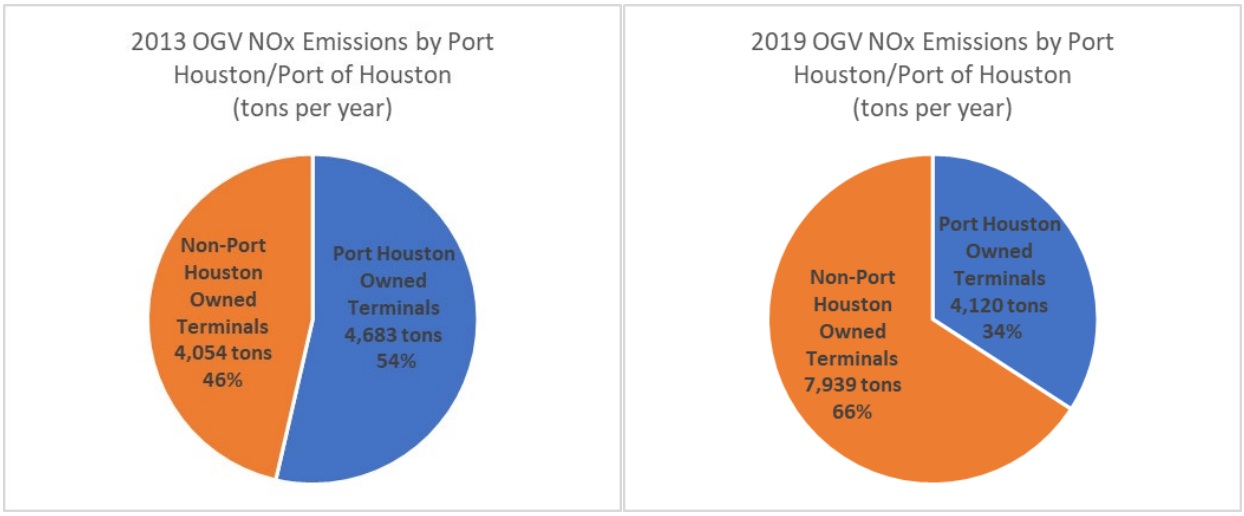
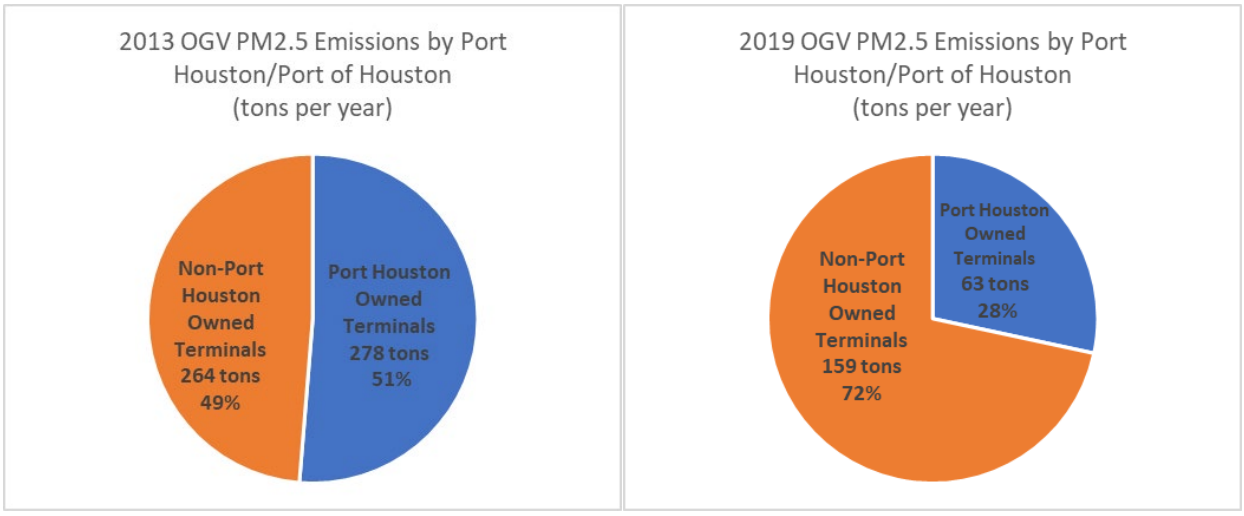


FIGURE 4 **PORT HOUSTON ASSOCIATED OGV PM2.5 EMISSIONS (TONS/YEAR)**



Heavy-duty Diesel Vehicles

Current advancements in heavy-duty truck technologies have created engines that emit fewer emissions while performing the same amount of work. Additionally, advancements in diesel engine technology now makes it possible to reduce NOx and PM2.5 emissions with nearly no loss in engine power. HDDVs account for 20% of total NOx emissions and 35% of total PM2.5 emissions at Port Houston in 2019 as illustrated on **Figure 1** and **Figure 2**. HDDVs in this category are also known as drayage trucks. Port Houston does not own or operate HDDVs in this source category. As such, Port Houston is committed to working with industry partners to influence emission reductions in the source category. The following analysis looks at both in-terminal emissions, the emissions generated within Port Houston terminals, and off-terminal emissions, the emissions generated outside of Port Houston terminals within the Houston-Galveston-Brazoria ozone nonattainment area. Port Houston has the most influence over in-terminal HDDV activity. In 2019, there were approximately 2,862,153 HDDV gate visits from drayage trucks servicing Port Houston which is an increase of 36% from 2013. Even with this increase in drayage truck activity, in-terminal HDDV NOx and PM2.5 emissions were lower in 2019, with in-terminal HDDV activity accounting for approximately 14% of the total NOx and 19% of the total PM2.5 emissions for the HDDV source category in 2019 as shown on **Figure 5** and **Figure 6.**

FIGURE 5 PORT HOUSTON HDDV IN-TERMINAL NOX EMISSIONS (TONS/YEAR)

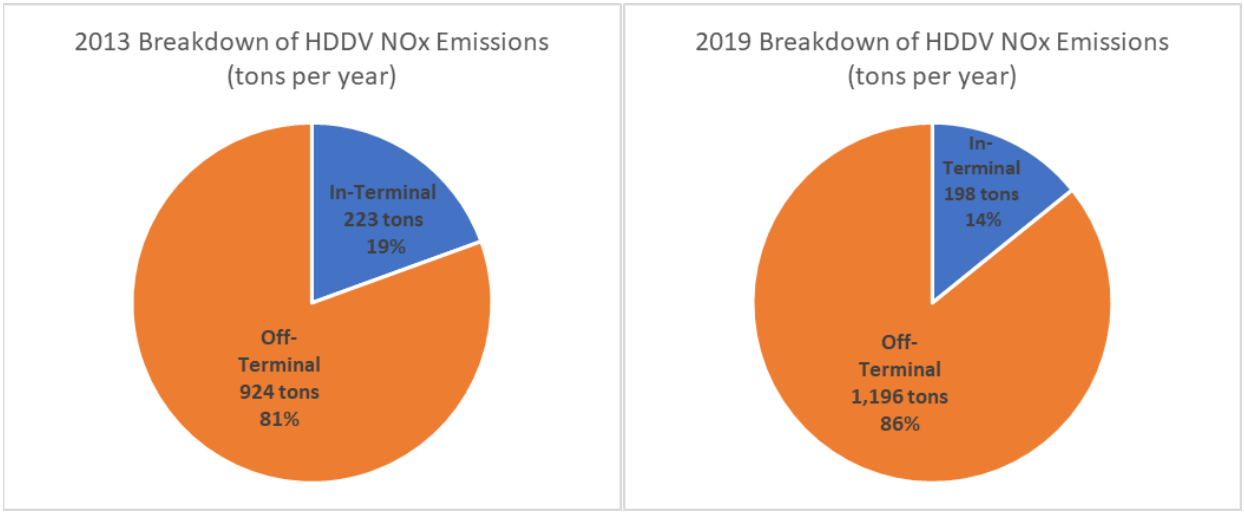
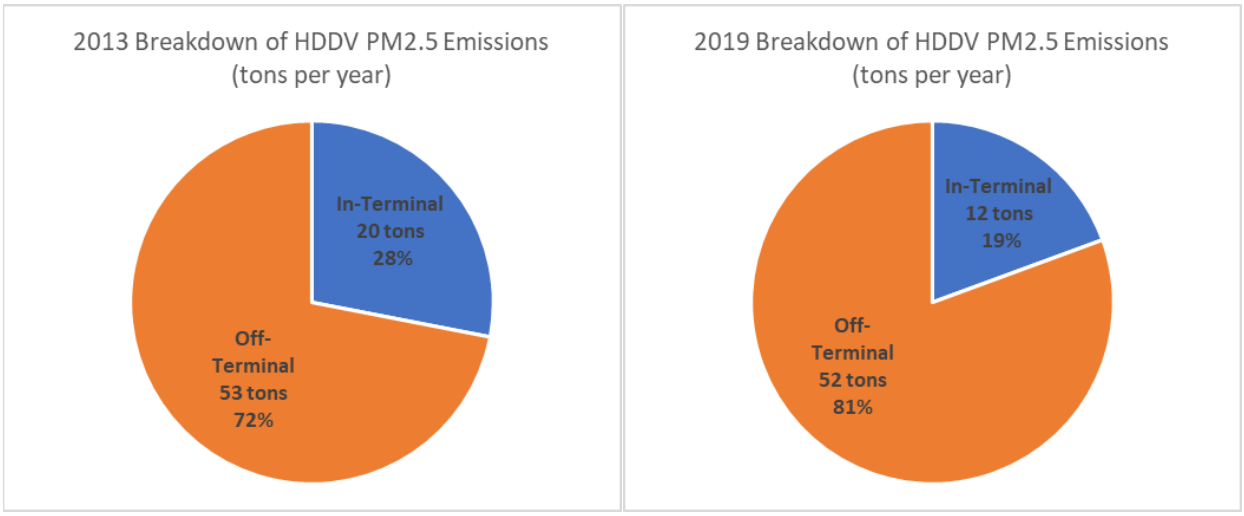


Figure 6 Port Houston HDDV In-Terminal PM2.5 Emissions (tons/year)



At least 91% of in-terminal emissions were generated at Port Houston-operated terminals in both 2013 and 2019 for both NOx and PM2.5 as shown on **Figure 7** and **Figure 8.** The Port Houston operated terminals include Turning Basin, Bayport, and Barbours Cut. Implementing HDDV emission reduction strategies at these Port Houston terminals has the potential to significantly reduce HDDV emissions related to Port Houston-owned facilities.

FIGURE 7 PORT HOUSTON-OPERATED IN-TERMINAL HDDV NOX EMISSIONS (TONS/YEAR)

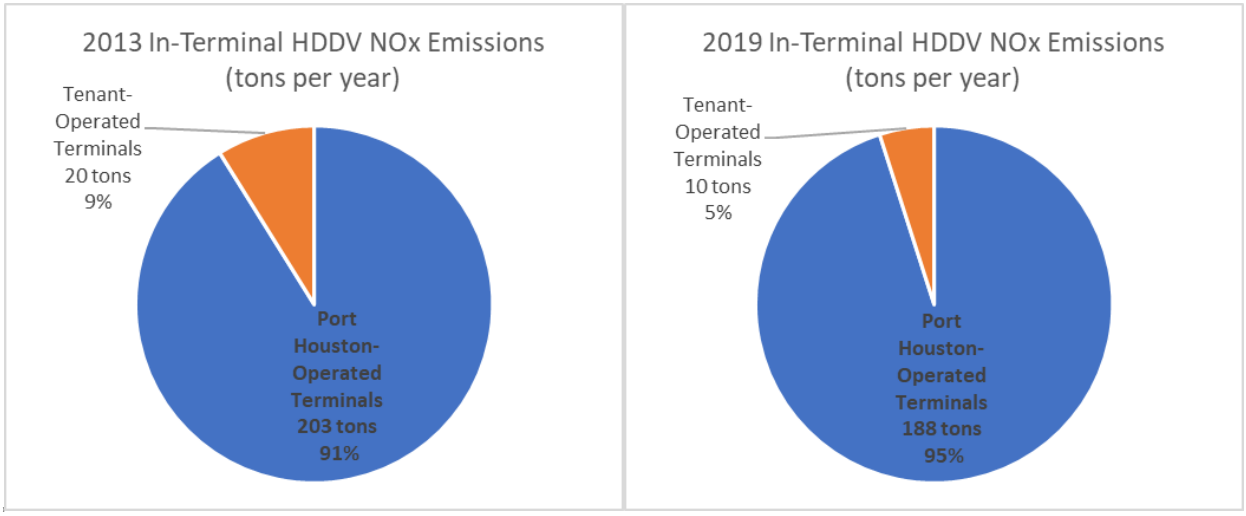
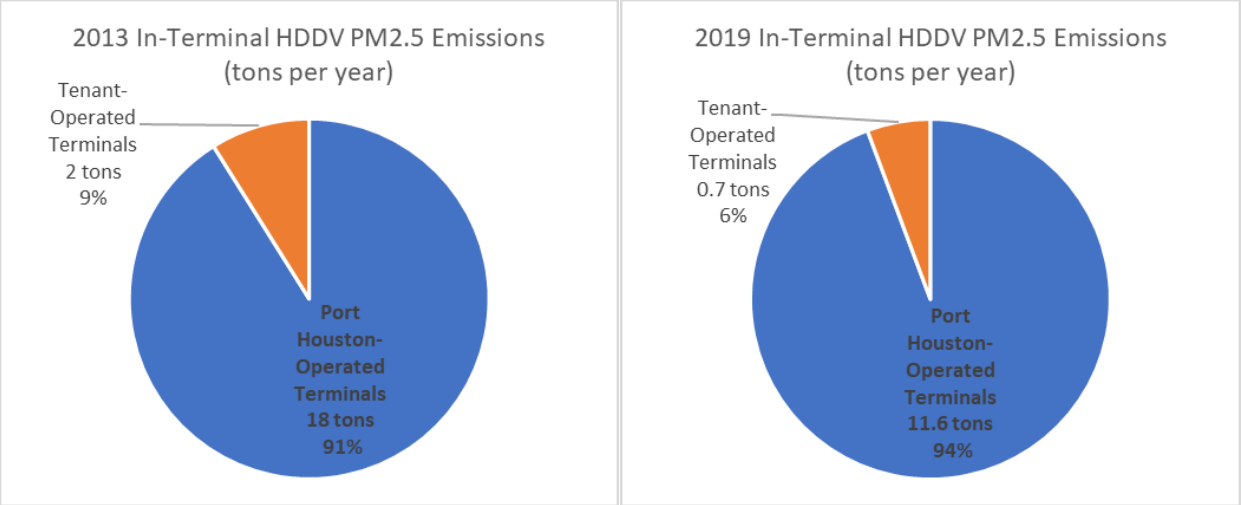


FIGURE 8 PORT HOUSTON-OPERATED IN-TERMINAL HDDV PM2.5 EMISSIONS (TONS/YEAR)



Cargo Handling Equipment

CHE accounts for 5% of total NOx emissions and 15% of total PM2.5 emissions at Port Houston in 2019 as illustrated on **Figure 1** and **Figure 2**. Furthermore, **Figures 1** and **2** show that CHE emissions were 72% lower for NOx and 70% lower for PM2.5 in 2019 compared to 2013. Diesel engines in CHE are regulated by the United States Environmental Protection Agency (EPA.) which range from Tier 0 (unregulated) to Tier 4 Final which is the most stringent. The reductions in CHE emissions can be attributed to improvements in the CHE fleet. As shown on **Figure 9** and **Figure 10**, Tier 0 and Tier 1 CHE account for 25% (down from 48% in 2013) of the total CHE NOx and 26% (down from 55% in 2013) of the total CHE PM2.5 emissions. The effects of cleaner CHE can also be seen in **Figures 9** and **10** when looking at the CHE population in 2019. The 25% contribution to 2019 CHE NOx emissions comes from 266 pieces of CHE while a greater amount (319 pieces) of Tier 4 Final CHE only represents a 7% contribution (PM2.5 emissions follow the same pattern). Therefore, cutting the use of Tier 0 and Tier 1 equipment operating at Port Houston facilities would result in significant reductions in NOx and PM2.5 emissions.

FIGURE 9 PORT HOUSTON CHE NOX EMISSIONS BY TIER

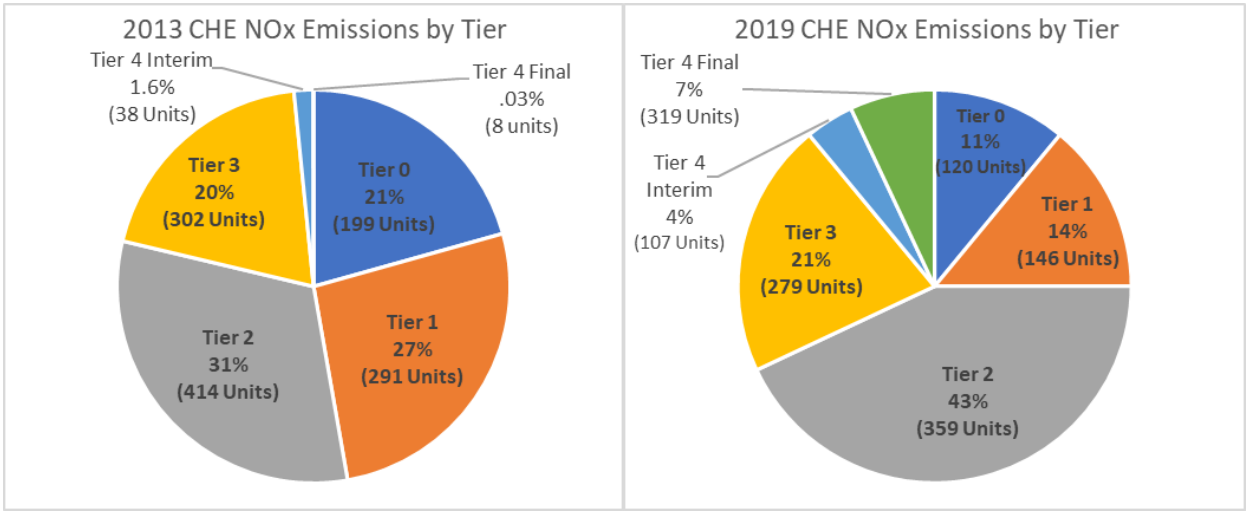
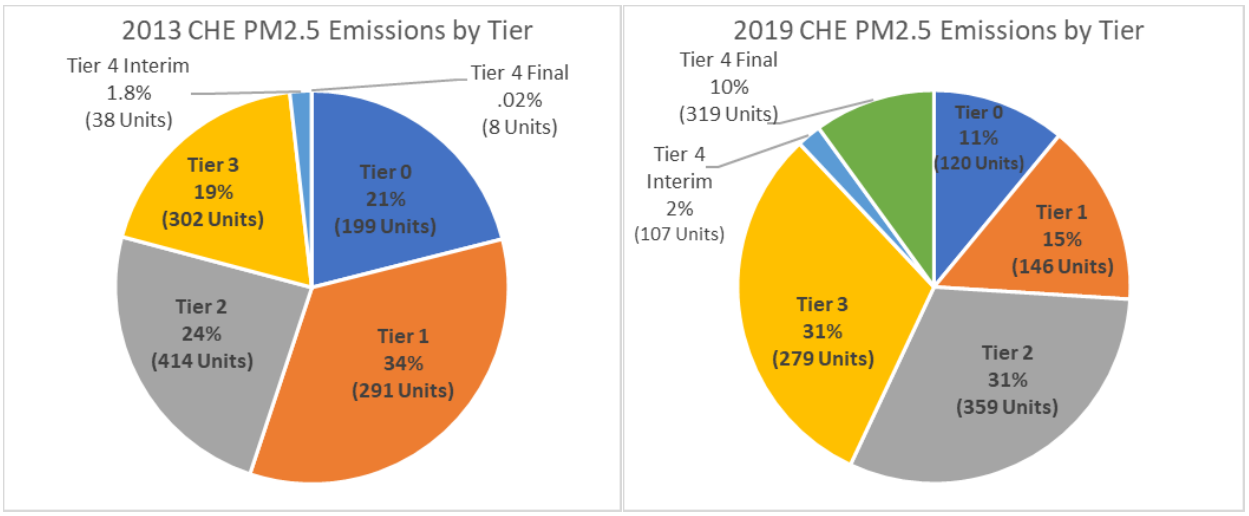


FIGURE 10 **PORT HOUSTON** CHE PM2.5 EMISSIONS BY TIER



As mentioned previously, Port Houston operates three of the Port Houston-owned terminals (Turning Basin, Bayport, and Barbours Cut). However, not all CHE operated on these terminals are owned by Port Houston. **Figure 11** and **Figure 12** illustrate that, all though the total NOx and PM2.5 CHE emissions decreased from 2013 to 2019, the contribution from Port Houston-owned CHE increased during this same period.

FIGURE 11 PORT HOUSTON CHE NOX EMISSIONS BY OWNERSHIP (TONS/YEAR)

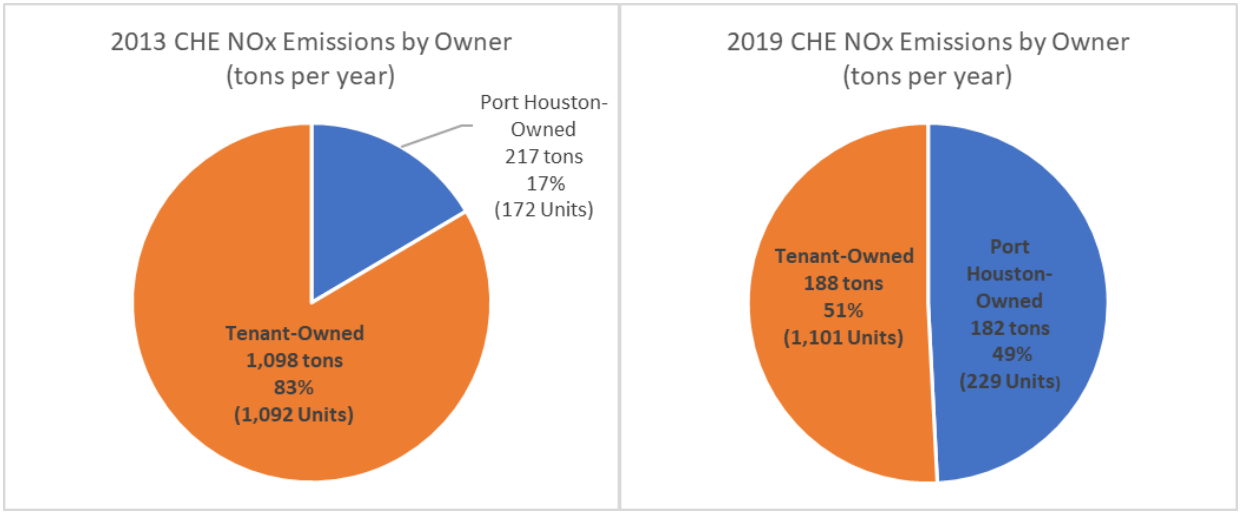
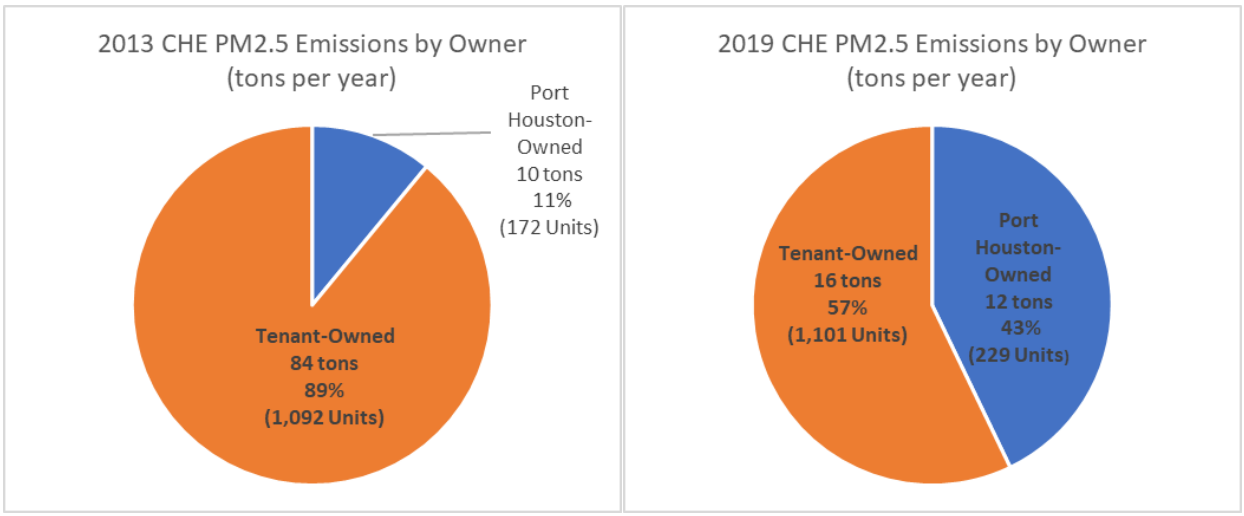


FIGURE 12 PORT HOUSTON CHE PM2.5 EMISSIONS BY OWNERSHIP (TONS/YEAR)



Locomotives

As seen on **Figure 1** and **Figure 2**, locomotive emissions were reduced by 8% for NOx and 26% for PM2.5 between 2013 and 2019. Due to federal exemptions and the transient nature of line-haul locomotives, Port Houston has limited control over these locomotives. However, switcher locomotives are locally operated by the Port Terminal Railroad Association (PTRA) and present an opportunity for emission reductions. The current switcher fleet operating at Port Houston runs on Tier 0 engines. The switcher (or Yard) locomotive emissions account for 12% of total locomotive NOx and 16% of the total locomotive PM2.5 emissions, as shown on **Figure 13** and **Figure 14**. It can also be seen from **Figures 13** and **14** that the switcher NOx emissions stayed

the same in 2019 as 2013 and increased slightly for PM2.5 in the same time period. Although efforts will need to be made to work with Class I railroad companies to reduce emissions since they are a bigger contributor of locomotive emissions, it will be important to work with PTRA also to reduce emissions as well since their contribution did not decrease within the locomotive source category.

FIGURE 13 PORT HOUSTON LOCOMOTIVE NOX EMISSIONS BREAKDOWN (TONS/YEAR)

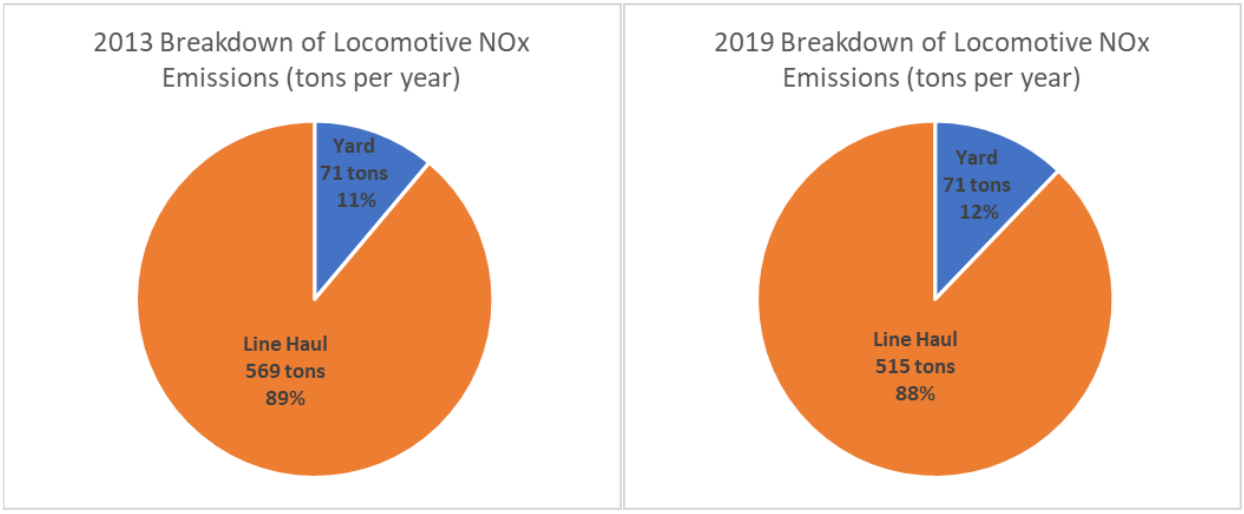
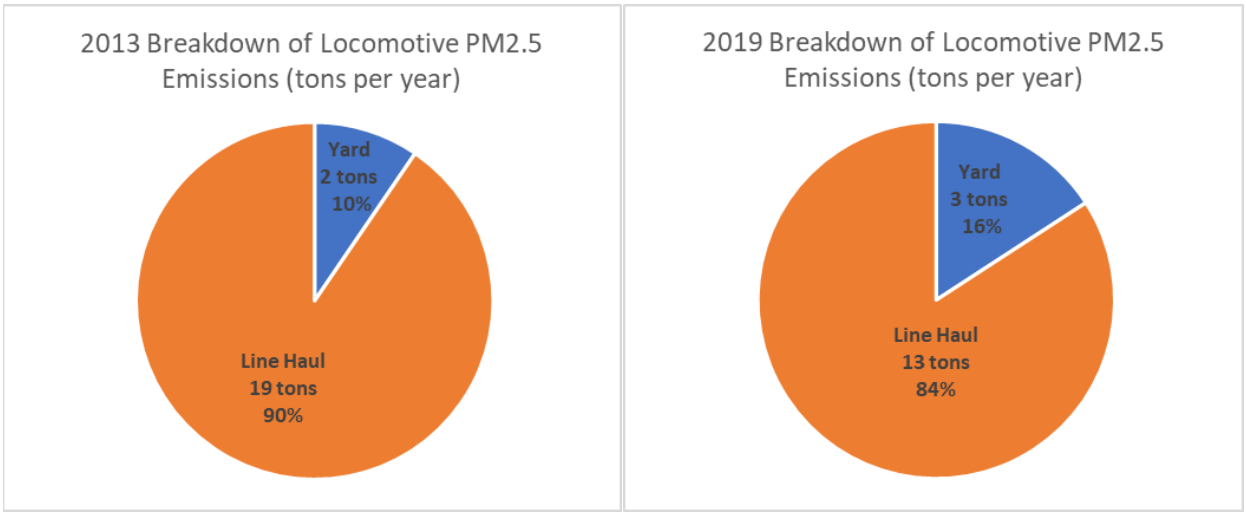


FIGURE 14 **PORT HOUSTON** LOCOMOTIVE PM2.5 EMISSIONS BREAKDOWN (TONS/YEAR)



Harbor Vessels

Per the *2019 GMEI*, HVs represent the second to the smallest source of NOx and the smallest source of PM2.5, as demonstrated on **Figures 1** and **2**. Also of interest, as illustrated in **Figure 15** and **Figure 16**, is that during this same time period, the HV NOx and PM2.5 emissions decreased

at non-Port Houston owned terminals. Port Houston does not own or operate HVs, and limited information is available about the vessel types in the HV fleet. Obtaining more detailed information on the fleet is important as Port Houston continues to refine its assessment of HV emissions.

FIGURE 15 PORT HOUSTON ASSOCIATED HARBOR VESSEL NOX EMISSIONS

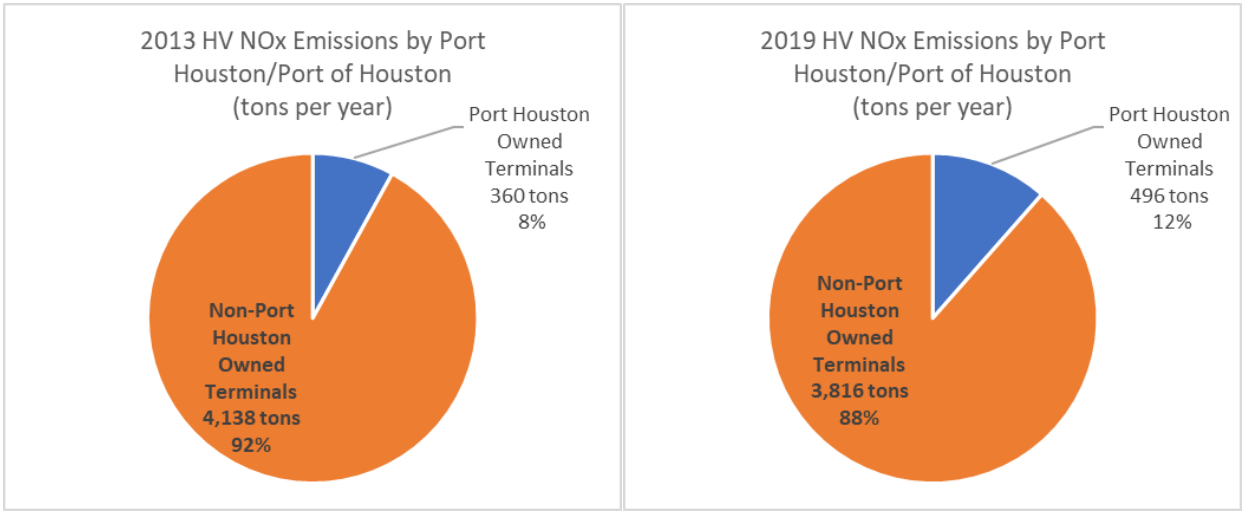
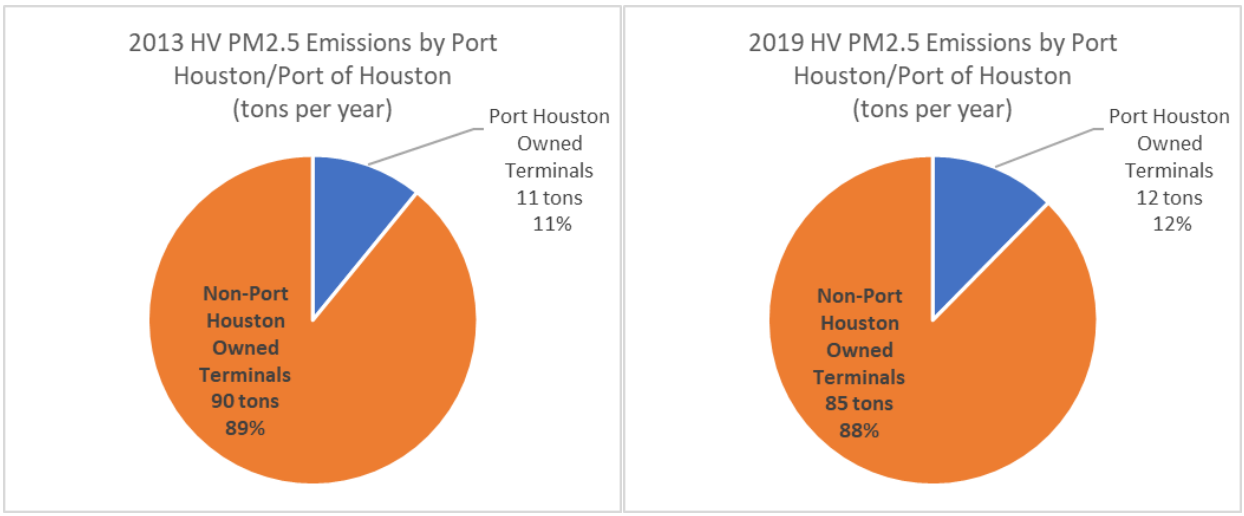


FIGURE 16 **PORT HOUSTON ASSOCIATED HARBOR VESSEL PM2.5 EMISSIONS**



Tugboat and Towboat/Pushboat vessel types in the HV fleet for the Port Houston terminals and the non-Port Houston terminals represent the majority portion of the NOx emissions as shown on **Figures 17** and **18**. According to 2019 GMEI, this fleet is operated with predominantly Tier 0 engines and therefore will have great potential for emission reductions.

FIGURE 17 **2019** PORT HOUSTON ASSOCIATED HARBOR VESSEL NOX EMISSIONS BY VESSEL TYPE

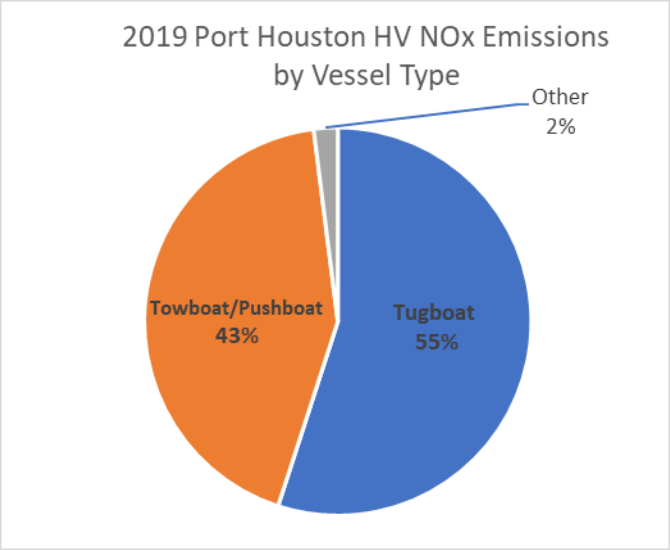
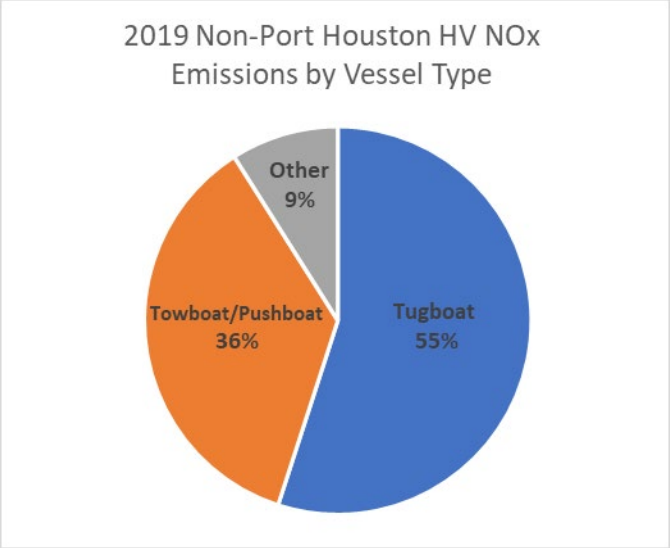


FIGURE 18 **2019 NON-PORT** HOUSTON HARBOR VESSEL NOX EMISSIONS BY VESSEL TYPE



Section 4. Emission Reduction Strategies

The *2021 CASP Update* takes a data-driven approach to identifying emission reduction strategies while considering economic and operational constraints as well as industry collaboration. This section identifies emission reduction strategies and tactics that target mobile source emissions at Port Houston-owned terminals. These strategies and tactics will require collaboration with industry partners as Port Houston does not solely control emission reductions from equipment and fleets it does not own. Emission reduction strategies have been shaped around specific actions, including:

- The development of emission reduction incentive programs;
- Feasibility;
- Port Houston's economic priorities; and
- Collaboration with industry partners.

By taking action over the course of the next 5 years (2022-2026), Port Houston aims to further reduce NOx and PM2.5 emissions at its terminals and work with industry partners to do the same.

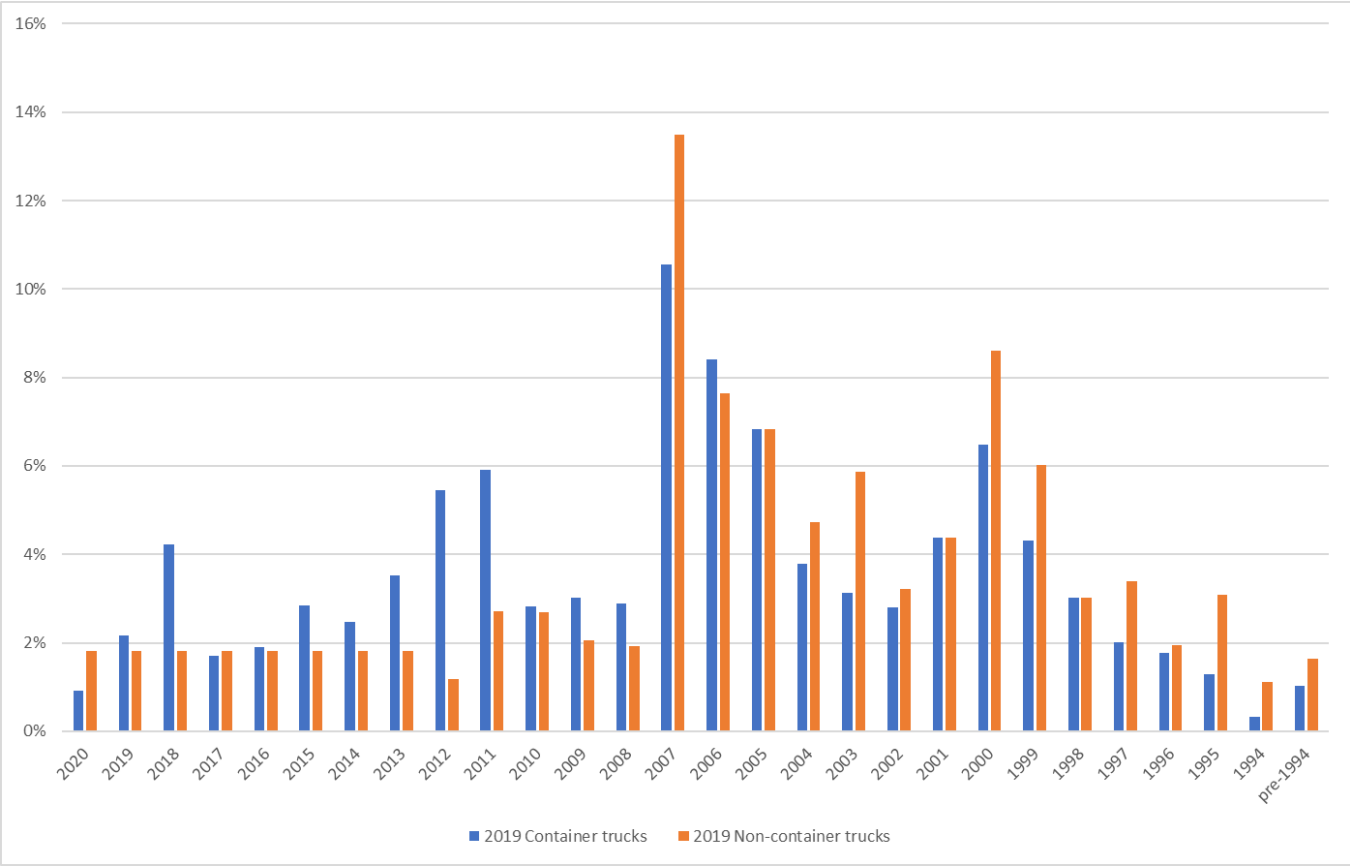
Strategy #1 — Upgrade Equipment and Technology to reduce emissions

As outlined below, drayage truck replacements, cargo handling equipment replacements, locomotive replacements or repowers, and harbor vessel replacements or repowers will greatly reduce NOx and PM2.5 emissions at Port Houston. The following identifies how the strategy can be applied to these source categories.

Tactic 1 — Promote Heavy Duty Truck population to newest emissions standards and support new fuels and technology adoption for lower emissions drayage trucks

In 2013, over 20% of the trucks accessing Port Houston terminals were model year 2010 and newer. Model year 2010 trucks and newer are subject to the fully phased in NOx standard requirement from EPA's 2007 heavy duty truck emissions standard. In 2019, 32% of trucks accessing Port Houston were model year 2010 and newer. **Figure 19** shows the truck age distribution for drayage trucks accessing Port Houston terminals as assessed in the 2019 emissions inventory. By discouraging the use of older drayage trucks, Port Houston has the potential to reduce HDDVs' NOx and PM2.5 emissions faster than normal fleet turnover.

FIGURE 19 PORT HOUSTON TRUCK AGE DISTRIBUTION



Implementation of incentives and other related initiatives would encourage the use of these cleaner model year 2010 and newer heavy-duty trucks while conversely discouraging the use of older, more polluting heavy-duty trucks. The goal for this tactic is that by the end of 2026, half of the drayage truck visits to Port Houston operated terminals (Bayport, Barbours Cut and Turning Basin) will be by model year 2010 and newer trucks. Focusing on this older segment of the fleet is the most direct way to reduce emissions from HDDVs. Implementing this tactic has the potential to reduce the total HDDV NOx and PM2.5 emissions by approximately 19% and 22% respectively as shown in **Table 2** and detailed in **Appendix F**. Implementing this tactic at Port Houston tenant operated terminals can be explored. However, as previously shown in **Figures 7** and **8**, about 95% of the in-terminal HDDV emissions are at Port Houston operated terminals. As such, only an additional 1.4 % and 1.5% reduction from the total HDDV NOx and PM2.5 emissions would be realized. Off-terminal HDDV emissions (i.e. within the greater Houston-Galveston-Brazoria area) would also be reduced through implementation of this tactic.

TABLE 2: PROJECTED IN-TERMINAL HEAVY-DUTY DIESEL VEHICLE EMISSION REDUCTIONS

Pollutant	Port Houston Operated Terminals	Tenant Operated Terminals
NOx	19%	1.4%
PM2.5	22%	1.6%

As mentioned previously in Section 3, Port Houston does not own or operate HDDVs in this source category and would need to influence the turnover of the HDDV fleet by working closely with other Port stakeholders to develop incentives and related programs. Examples of incentive programs that will be explored include, but not limited to, the following:

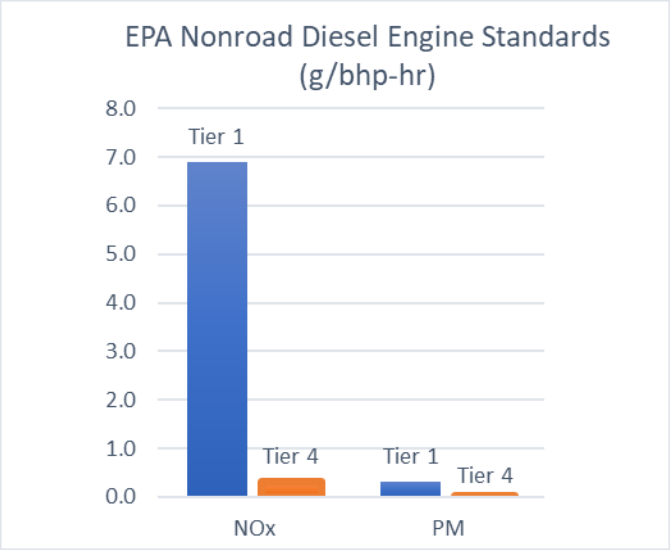
- Advocating for improvement of current state/federal grant programs and for the development of new grant programs to be better address the needs of the drayage trucking industry.
- Encouraging beneficial cargo owners (BCOs) and third-party logistics (3PLs) companies with targeted incentives to require trucks that are used to pick up their cargo be MY 2010 and newer.
- Encouraging drayage trucking companies with targeted incentives to dispatch trucks to Port Houston terminals that are MY 2010 and newer.
- Incentivize the use of MY 2010 and newer drayage trucks by adjusting the rates in the Port Houston Tariffs.
- Develop relationships with other Houston Ship Channel industries to be beneficiaries of Supplemental Environmental Projects (SEP) funds that could be used to fund incentive programs or directly provide for truck replacement.

Tactic 2 — Replace Port Houston Owned Tier 0 and Tier 1 Cargo Handling Equipment with Tier 4

As explained in Section 3, Port Houston owned cargo handling equipment (CHE) emission in 2019 were lower than it was in 2013. Port Houston owns 229 pieces of CHE which is 17% of the CHE population at Port Houston terminals. About 25% of the Port Houston owned CHE fleet is Tier 0 and Tier 1. Replacing Tier 0 and Tier 1 cargo handling equipment with Tier 4 CHE presents an opportunity to reduce emissions in this source category.

The Tier 4 EPA nonroad diesel engine standard is about 96% lower than the Tier 1 standard for both NOx and PM as illustrated in **Figure 20**. Tier 0 is not included in the figure because Tier 0 is another way to describe diesel engines that were manufactured before EPA started regulating exhaust from these engines. As such Tier 0 diesel engines would emit more, or at the very least, the same level of emissions as a Tier 1.

FIGURE 20 EPA TIER 1 AND TIER 4 NONROAD DIESEL ENGINE STANDARD



Implementation of this tactic for Port Houston owned CHE has the potential to reduce total CHE NOx and PM2.5 emissions by 9%. If Port Houston tenant owned Tier 0 and Tier 1 CHE is included in this tactic as well, an additional 15% reduction from the total CHE NOx emissions and 16% reduction from the total CHE PM2.5 emissions could be realized as shown in **Table 3** and detailed in **Appendix F**.

TABLE 3: PROJECTED CARGO HANDLING EQUIPMENT EMISSION REDUCTIONS

Pollutant	NOx	PM2.5
Port Houston Owned	9%	9%
Tenant Owned	15%	16%
Total	24%	26%

Tactic 3 — Encourage PTRA and Class 1 Railroads to replace and upgrade locomotives

Port Houston does not own or operate locomotives. Therefore, in order to reduce locomotive emissions Port Houston will need to collaborate with industry partners including Class 1 Railroad Companies, the Port Terminal Railroad Association (PTRA) and Port tenants to identify options to repower or replace locomotives. Replacing or repowering the current PTRA fleet would yield significant emission reductions in this source category by approximately 11% and 15%, respectively (see **Appendix F** for detail). Therefore, the modernization of the existing PTRA fleet presents an opportunity for direct, local emission reductions. However, replacing or repowering these locomotives depends on current lease arrangements between the operators and equipment

providers and would require collaboration between PTRA, Class 1 Railroads, Port Houston and other industry partners to pursue this tactic.

Tactic 4 — Support Harbor Vessel Tug and Tow operators to continue upgrading fleets

Port Houston does not own or operate harbor vessels. Similar to the Locomotive source category, industry collaboration is required to realize emission reductions from Harbor Vessels. Replacement or repower of lower tier tugboats can significantly reduce NOx and PM2.5 emissions. Tier 4 tugboats emit 88% less NOx and 85% less PM2.5 emissions when compared to Tier 0. Replacing 20% of the tugboats in the HV fleet with Tier 4 engines could reduce NOx and PM2.5 emissions by 14% and 11% (see **Appendix F** for detail) respectively in the HV source category.

Port Houston is collaborating with tug and tow operators to influence encourage fleet upgrades, support new technology development and also applying for DERA grants and other assistance that can accelerate the fleet conversions. As mentioned in Section 3, the 2019 GMEI documented harbor vessel fleet is 63% Tier 0 and 26% Tier 2 and 3, so there is room for upgrades as this fleet turns over. Nevertheless, leaders in this industry of tug and towboat fleets have been making continual strides in continually upgrading their fleets. Interviews with leading operators indicate that due to equipment upgrade initiatives in recent years, over 60% of the ship assist tug fleet are at Tier 2 and 3, and the largest towboat fleet in the area has reduced the Tier 0 element of their fleet by 98% in the past two decades, and in the most recent 10 years has reduced Tier 1 by 37% and increased Tier 2 and 3 by 94% and 30% respectively.

Operators are investigating Hybrid Electric / Fuel Cell and Fully Battery Electric technology for future fleet additions, and Port Houston is promoting these developments through its legislative monitoring and its role in advocacy groups such as the Blue Sky Maritime Coalition.

Strategy #2 — Implement Operational and Technological Efficiencies

The efficient movement of cargo has the potential to significantly reduce emissions from diesel powered equipment. The following tactics are designed to optimize operations and move cargo more efficiently at Port Houston terminals. For Port Houston in 2019, OGV and HDDV categories contributed 79% of the NOx emissions and 69% of the PM2.5 emissions (5,515 tons and 127 tons respectively). These tactics below have potential to reduce emissions further from the HDDV source category and to make emissions reduction from the OGV as well.

Tactic 5 — Maintain industry leading truck turn times and minimal idling by improving terminal gate capacity, cargo position detection systems and truck entry and exit processing technologies

Streamlining the process of entering and leaving a terminal (also known as the turn time) can be achieved through the implementation of technological and operational efficiencies.

Customized information technologies can improve how cargo data flows through the greater Port of Houston community. Technology that adjusts driving behaviors in and around Port Houston terminals can help reduce truck emissions. Operational efficiencies can also result in reduced turn times, which can lead to emission reductions. **Table 4** includes examples of information technological and operational efficiencies that have proven to reduce turn times and emissions at other ports and will be evaluated for the feasibility of implementation at Port Houston.

TABLE 4: HEAVY-DUTY DIESEL VEHICLES' TECHNOLOGICAL EFFICIENCIES

Strategy	Description	Example	Benefits
Truck Appointment System	Implementing a dynamic software system gives drivers and terminal operators a sense of the best time to pick up a container and is based on a number of variables, including driver availability and traffic conditions.	Since 2014, varying degrees of truck appointment systems have been implemented at ports around the nation including Los Angeles/Long Beach, New York/New Jersey, and New Orleans.	With advancements in cargo data information, terminals can pre-plan their moves to reduce congestion and wait times at both terminal gates and within the terminal.
Bluetooth Technology	By using Bluetooth proximity readers in and around the marine terminal, software systems can communicate congested locations to truckers and dispatchers.	Bluetooth technology is currently being used at the Port of Oakland as part of a wait time tracking and reporting tool.	When a drayage truck gets to a terminal gate, pings in Bluetooth technology will relay information to the driver about the most efficient lane to get into and out of the quickest.
RFID Tags	Wireless technology streamlines gate and truck registry data collection.	RFID data is being used at the Port of Los Angeles/Long Beach and the Port of Seattle.	RFID tags help improve data accuracy and gate processing times.
GPS Units	Some truck programs require the use of GPS units to track mileage and destination information.	GPS is used at most ports nationwide.	Generates rich data sets for further efficiency refinements.
Idling Reduction	Measures are being taken by ports to facilitate less idling.	The Port of Vancouver USA has established an anti-idling campaign.	Overall efficiency gains may reduce idling.

Notes:
RFID = radio-frequency identification
GPS = Global Positioning System

Tactic 6 — Explore opportunities to move container cargo increasingly to rail and other alternative transport modes / intelligent transportation systems

In April 2019, Port Houston commissioned an Integrated Multimodal and Operational Study, supported by a grant from Texas Commission on Environmental Quality and with technical support from AECOM and Environmental Defense Fund. The objective of this study was to define ways to move containerized cargo off status quo trucks and onto other modes including rail, lower emission road trucks, barges, and alternative intelligent transportation systems (electric shuttles), as well as reducing emissions from cargo handling equipment.

One of the five container freight intermodal opportunities evaluated was a Shift from Road to Rail. The study concluded there is an emissions reduction benefit due to the economy of scale advantage of moving 350 containers (or truck trips) to one train. Moving containers by rail reduces trucks trips and reduces emissions. The study also points out increasing rail service requires buy-in from external stakeholders including the shippers and the railroads themselves.

A second method of reducing over-the-road traffic was exploring the potential of containers-on-barges (COB). COB operations currently exist as a small supplement to regular ship-borne container cargo operations and may serve a niche amount of cargo. Port Houston subsequently worked with MARAD to implement a pre-engineering planning study to define how operations might be optimized. Port Houston is continuing to work with MARAD to monitor the American Marine Highways program initiatives and support such where possible.

A third method of moving container traffic off the road and onto alternative modes includes an elevated guideway system where containers are moved by electric vehicles separated from traffic, improving safety, emissions, and road maintenance costs. This system would require substantial capital investment and a coalition of investors and cargo shippers. Port Houston is actively discussing the concept evolution.

In addition, a fourth mode would be to transition container traffic to lower / no-emission vehicles. Port Houston is addressing the potential of such shifts through dialogue with cargo shippers, trucking companies, and trucking OEM's developing new clean tech tractors and associated technology. Key to this evolution will be connecting the demand function (drayage trucking) to supply (affordable and available equipment, fuel production and fueling infrastructure).

Tactic 7 — Coordinate Partnerships for At-Berth Ship Emissions Reductions

Port Houston is pursuing feasible technical options for reducing dockside emissions from OGV's and has included this opportunity in the Sustainability Action Plan. New technologies including barge mounted emissions capture systems and mobile electric power sources using alternative clean fuel technologies can accelerate the adoption of emission reduction technologies.

While examples of shore power and waterside emissions capture exist to emulate, implementation is not simple. Both methods have operational, technical and regulatory challenges which must be addressed. Implementation of these options requires coordination and agreements across

multiple parties including the terminals, cargo operations compatibility, vessel owners, power providers, US Coast Guard, Houston Pilots and regulatory authorities where emissions credits are concerned; positive support from community and environmental advocates for policies that support related grants or emissions reduction credit policies can help.

It should be noted that in locations where regulatory mandates require use of shore power and capture and control systems, adoption of both shore-side electricity and ship-side emissions capture technology has been accelerated. Adoption has been supported in part by dedicated berthing assignments and sufficient predictability of operations to enable amortization of related investments, as well.

Absent similar regulatory requirements in the Texas markets, and with more fluid and flexible operations as occurs in Houston, Port Houston is actively exploring market-based options that align stakeholders. Value propositions for operators and service providers include providing revenue earning services, earning emissions based (e.g. carbon, NOx) based credits, and support of vessel owner and service providers' own sustainability goals. As such, dialogue around both ship-side emissions capture and shore-side power is on-going. Port Houston has already begun analyzing the feasibility of at-berth emission capture and control systems at its container terminals by looking at past vessel visits to Barbours Cut and Bayport to inform future usage and optimization as well as working with the Houston Pilots to identify any navigational/safety concerns.

Shore Power

Using electrical power for ships while at-berth rather than diesel-burning auxiliary engines greatly reduces air pollution from OGVs. When ships use shore power, they utilize landside electricity for their power needs at-berth instead of running diesel-fueled auxiliary on-board engines. Shore power can reduce air pollution from ships at berth by 95%. Making shore power available requires considerable infrastructure enhancements at Port Houston berths as well as on the vessels that receive power. A commitment from vessel owners is required to realize the emission reduction benefits of shore power infrastructure. Port Houston is committed to exploring this option internally through infrastructure upgrades as well as through communications with vessel owners.

Ship-Side Emission Capture Systems

Ship-side emission capture and control systems have been proven to reduce NOx by 99% and PM2.5 emission by more than 95%. Ship-side emission capture and control technology could be used as an alternative to shore power and has been shown technically feasible in other ports.

Tactic 8 — Optimize application of clean technology in dredging operations including Project 11

Improving the Houston Ship Channel is one of the most important and strategic infrastructure projects in the nation. Substantial detail describing this effort known locally as "Project 11", can be found at www.widenthehoustonshipchannel.com but the main aims of this project are

expanding the width up to 700 feet and depth up to 46 feet to make the channel more efficient and safer.

A consequence of a wider, safer channel is better transit efficiency, and the completed project will improve emissions from passing vessels from 3% to 7% per year over the projected life. These benefits are net of impacts due to construction, which have been incorporated into the emissions calculations and are approved through NEPA and TCEQ. Nevertheless, Port Houston has negotiated equipment upgrades with dredging suppliers to greatly exceed the minimum standards established during design. Projected emissions rates for the first segment of this project will exceed Tier 3 standards by 38%, versus a minimum of Tier 1 equivalence. Moving forward, a similar approach to optimizing value and emissions reduction will be incorporated into future dredging contracts.

Tactic 9 — Reduce Emissions from Idling Vehicles

Anti-idling Program

The application of anti-idling technologies is proven to drastically reduce emissions. Creating an anti-idling program which prevents HDDVs and CHE from unnecessary idling for significant periods when parked or otherwise not in motion is a simple way to reduce emissions, fuel costs, noise pollution, and needless engine wear-and-tear.

An anti-idling program encourages drivers and equipment operators to turn off their engines when not in use. The biggest challenge to implementing an anti-idling program is educating operators. There is often the misconception that frequently starting and stopping an engine uses more fuel and/or causes additional wear-and-tear on the vehicle. This may have been a concern in the past, but with present day fuel-injection engines, starting systems are more efficient and do not require as much fuel to start an engine.

Locomotive idling can be reduced by connecting to the grid or using Automatic Engine Stop Start (AESS) technology. AESS technology incorporates fully integrated devices that monitor critical operating parameters during locomotive idle operation and safely/effectively shuts down the engine when all factors are satisfied. When any one of the predetermined limits falls outside of the target range, AESS will restart the engine. New locomotive technologies, such as AESS, would reduce emissions from switcher idling and promote fuel efficiency.

Strategy #3 — Promote partnering and collaborative alignment with stakeholders

Collaboration is a key theme throughout the *2021 CASP Update*. Actively working with industry partners to pursue emissions reductions is a joint effort. Replacing equipment and adding new technology can be costly. A coordinated and unified message will have greater influence on policy makers, regulators, and legislators. The following tactics illustrate how collaboration can yield emission reductions.

Tactic 10 — Develop Grant Programs to Pursue State and Federal Funding to Reduce Mobile Source Emissions

The development and implementation of grant programs to attract funding for the replacement or repower of equipment and to procure new technologies has proven successful at ports across the country. Port Houston shall continue to work with partnering agencies and stakeholders to leverage regional, state, and federal funding to reduce emissions in each source category. This approach will help with replacement of the oldest equipment in the fleet, advance the clean-equipment technology within the industry, and position Port Houston as a leader and innovator.

Port Houston's approach to developing grant programs includes identifying funding sources and drafting project plans with stakeholders during the planning process to target funding for drayage trucks, and Tier 4 engine technology for CHE, locomotives, and harbor vessels.

Port Houston has a history of successfully pursuing and winning grant funding. Port Houston has been awarded grant funding for emission reduction projects from the following agencies and grant programs:

- U.S. EPA — Diesel Emissions Reduction Act
- U.S. Department of Transportation — Transportation Investment Generating Economic Recovery (TIGER) Grant
- U.S. Department of Transportation Marine Administration — Port Infrastructure Development Program
- Harris County — Local Initiatives
- Texas Commission on Environmental Quality — Texas Emissions Reduction Plan
- Houston Galveston Area Council

Emission Control Retrofits

Grants for retrofits to reduce NOx and PM2.5 can be pursued for tugboats with substantial remaining useful life until these vessels are viable candidates for replacement. Port Houston can facilitate the installation of NOx and PM2.5 retrofits on a series of vessels that represent 79% of the NOx emissions and 70% of the PM2.5 emissions of the harbor vessels source category.

Tactic 11 — Promote freight mobility projects which improve road and rail traffic conditions, and invest in related projects where connected to port properties

Improving the efficiency and effectiveness of road and rail networks not only lowers overall transportation and consumer costs but substantially reduces low-velocity goods movement and relatively high emissions rates. Debottlenecking these networks has a material improvement impact on regional air quality.

Port Houston established a freight mobility program which collaborates with regional planning organizations and private industry to identify, prioritize and fund network improvements. Some of these projects are under jurisdiction of city, county, state and federal authorities, so Port Houston advocates for funding grants and appropriations as well as supports regional

transportation plans and strategies where freight is concerned. This advocacy has helped garner several tens of millions of dollars toward such projects and where port specific assets were concerned, Port Houston has provided local matches. These efforts have improved road and rail efficiency with a commensurate impact on emissions and air quality. Double-tracking and eliminating at-grade crossings are also examples of operational efficiencies that will reduce idling and wait times which reduce emissions related to this source category.

Port Houston is leading the effort with others to renew the project list to further impact emission rates in the area.

Tactic 12 — Support area-wide vessel scheduling optimization

A vessel scheduling system helps synchronize the simultaneous operations that must be performed during a vessel call. Deviations from vessel call plans can result in inefficiency and lead to productivity loss, additional fuel consumption, and surplus air emissions. The Greater Houston Port Bureau identified over $360 million in operating value related to extra time spent in port beyond a "best case" scenario, and there is an analogous opportunity for reducing air emissions from unnecessary transits, idling and anchorage time of OGV's. Most of these OGV's do not call on Port Houston facilities, however overall efficiency of all vessels using the Houston Ship Channel, and the impacts on air quality remains a concern. Therefore, supporting efforts that improve all OGV vessel port calls is an appropriate tactic for CASP.

Vessel scheduling systems harmonize digital tools that increase transparency and optimize supply chain performance. Optimization can result in emission reductions and better utilization of the Houston Ship Channel in the greater Port of Houston area.

This optimization can be difficult to achieve because it involves myriad private facilities and ship owners as well as cargo schedulers and vessel agents, etc. The Greater Houston Port Bureau has initiated a vessel and terminal planning software platform currently being upgraded and reformed as "Synchronizer". Port Houston will continue to support the Port Bureau to optimize this platform.

Tactic 13 — Promote development of alternative fuel production and distribution infrastructure for vessels and trucks, and carbon capture and supporting infrastructure in the Port area

Port Houston recognizes that collaboration with industry partners can play a significant role in facilitating fueling infrastructure for hydrogen, natural gas, and electrification. Port Houston foresees commercial opportunities in production and storage of alternative fuels because of increasing demand. In order to create the necessary infrastructure, this tactic would look at how Port Houston could develop an alternative fuel chain parallel to the existing fuel supply system. This enables the owners and operators of alternative fuel powered vehicles/equipment to refuel efficiently and within proximity to Port operations. Facilitating access to alternative fueling infrastructure can make this a viable option for the drayage truck community.

As mentioned in Tactic 6 moving to lower emission road transport, key to this evolution will be connecting the demand function (drayage trucking) to supply (affordable and available equipment, fuel production and fueling infrastructure). The industry faces a "chicken-and-egg" dilemma requiring fuel supply and infrastructure to be in place at the same time as affordable alternative truck technologies which meet operational and economic requirements of trucking firms. Port Houston is engaging with multiple parties across this value chain and including consortia who may bring complete solutions to the situation to seed or pilot demonstrations of new lower emission transportation and trucking. Strident coordination with public funding sources and policy makers is also essential to executing this Tactic successfully. However, if successful, HDDV's as a source of NOx and other pollutants can be impacted positively.

Similarly, and in concert with the gray, blue, green hydrogen outlooks, Carbon Capture Utilization and Sequestration (CCUS) initiatives are being formulated at the plant, partnership, and regional strategy levels. Port Houston is working with multiple companies and organizations to promote CCUS in the overall development scenarios for Houston's future. While a popular and primary aim of CCUS is to mitigate global climate change, from a CASP perspective, the actions involved will be expected to have positive impacts on overall air quality. Some environmental entities have expressed concerns about the viability of systems involving hydrogen and carbon capture, yet the engineering and feasibility analysis for these systems will address such issues. Port Houston is supporting these large initiatives and talking part in dialogue regarding individual projects. In many cases, the Port will be a connector within a larger ecosystem, and in some cases where sensible, will take part in specific projects and working groups.

Tactic 14 — Align emissions reduction goals with suppliers, operators and other parties' sustainability goals including partnerships and application of clean technology

Numerous parties ranging from energy companies and manufacturers to ocean and over-the-road carriers, to cargo owners and shippers, have their own motivations and goals for impacting air quality from local emissions to global climate change. Entrepreneurs are introducing innovative ways for producing clean fuels, promoting new transportation technologies and trucks and vessels technologies in interest to affect our sustainable environment as well as capture new business opportunities. Port Houston is collaborating with many of these companies and institutions such as The ION, Greentown Labs, and multiple universities in Texas, as well as exchanging ideas through such venues as conversations with Ports of Vancouver, Antwerp and Rotterdam as well as industry coalitions like Blue Sky Maritime Coalition and the IEA World Hydrogen Ports Coalition, and the Center for Houston's Future and Greater Houston Partnership. In addition, this dialogue includes key non-governmental agencies and community and environmental advocates such as the Healthy Ports Communities Coalition, Air Alliance Houston, and the Coalition of Community Organizations.

Together these discussions promise additional innovation, creative thinking and building of shared understanding across stakeholders so that the CASP goals and strategies can be implemented more effectively.

Tactic 15 — Advocate for local, state and federal policies which support emissions reduction

Port Houston's Office of External and Government Relations and our Grants Management Department continually monitor developments in public policy including grants programs such as the Port Infrastructure Development Program, and other funds being made available through the Infrastructure Bill and other legislation to come. All opportunities to improve air quality through new technology, mitigations and restorations, and grants sought on behalf of others, is being pursued.

Tactic 16 — Develop and Implement the Sustainability Action Plan

Port Houston has a variety of sustainability initiatives currently being implemented to improve the conditions of the community. Port Houston has reviewed the current initiatives and has met with a broad range of stakeholders to review future endeavors for port sustainability. To allow for continued improvement, Port Houston has committed to additional programs to create the Port Houston Sustainability Action Plan (SAP) Initiatives. The plan and its accompanying ES^{2}G Report are posted on Port Houston's website, currently under www.porthouston.com/esg .

The initiatives discussed for the SAP have been organized into 4 focus areas, Environment, Social, Safety, and Governance. Each focus area contains multiple initiatives that Port Houston will either lead, partner, or support to improve clean energy, air quality, community strength, and transparency. **Table 5** presents the basic list of sustainability initiatives and definitions. A full list of initiatives can be found online on the Port Houston website in the Port Houston SAP.

TABLE 5: SUSTAINABILITY ACTION PLAN INITIATIVES AND DEFINITIONS

Initiative	Description
Lead Initiatives	
Cargo Handling Equipment Electrification	The Electric Yard Mule Pilot, initiated from a TCEQ sponsored Emissions Redux study, will be evaluated to determine if it can bear the required cargo loads.
Freight Mobility Renewal	This effort is being renewed from the Port Houston Economic Alliance freight mobility projects list developed in 2016.
Maritime Education Outreach	Increase partnerships with institutions that support Maritime workforce development and expand Maritime education opportunities to include additional schools.
Community Engagement Events	Organize events for the benefit of the community to build awareness for environmental, social, and supplier diversity programs.
Parks and Green Spaces Revitalization	To improve health equity and strengthen communities near the Houston Ship Channel, Port Houston will lead initiatives to construct, repair, and/or enhance local parks and green spaces.
Economic Development Job Creation	The Port Houston Economic Development's goal is to attract new cargo to generate additional jobs. The Greater Port Economic Impact includes 3.2 MM jobs nationally and 1.35 MM in Texas.

Diversity, Equity, and Inclusion Initiatives	To create a positive social and economic impact that improves the quality of life for the communities served by fostering a culture of diversity, equity, inclusion, innovation, and open communication.
M/S/W Business Equity Program	Create a Business Equity Division whose focus is to expand opportunities for minority, small, and women-owned business enterprise program.
Partner Initiatives	
Alternative Fuel Drayage	Collaborate with truck and cargo owners to accelerate the switch to class-8 electric trucks for container drayage while reducing financial risks for truck owners.
Solar PV and Energy Storage	Create proposals to build Solar PV and energy storage on Port property.
Marine Fuel Alternatives	Provide support to industry partners for the use of alternative fuel bunkering marketplace and infrastructure.
Dockside Emissions Redux	Collaborate with partners to utilize exhaust capture and/or shorepower infrastructure systems to limit emissions from vessels.
DERA/TERP Repower Grants	Increase the submittal of DERA/TERP grant applications to allowed expanded grant application to additional Port equipment.
Plastics Pyrolysis Value Chain	Currently, plastics to fuel recycling is commercialized by multiple companies. Port Houston has the goal to be part of a sustainable business park, which receives post-consumer plastic and connects it to the pyrolysis value chain.
Harbor Street	• Port Houston donated 22 acres and augmented funds for Buffalo Bayou Partnership (BBP) east end master planning to envision its potential for community development and resiliency facilities. • Port Houston stands with Houston and BBP as the city's emerging project becomes reality.
50/50 Parks Board	Port Houston accepted Houston Mayor Turner's challenge and committed $1MM over 4 years as Founding Park Partner Level in Houston Parks Board's park development program.
Legislative Advocacy	Discuss carbon reduction technologies and infrastructure with lawmakers and provide letters of support to stakeholders for environmental and social/community justice issues.
Environmental Mitigation Bank Co-Development	Partner with the Harris County Flood Control District for the creation of a wetlands mitigation bank.
Support Initiatives	
Blue Sky Maritime Coalition	• Acts to accelerate the U.S. and Canada maritime value chain's pathway to net zero GHG emissions. • Cross-functional collaboration will be utilized to enable swift mobilization and tangible, sustainable results.
IEA Hydrogen Ports	Clean Energy Ministerial Global Ports Hydrogen Coalition supports the scale up of clean hydrogen in global economies.
Innovation/Incubators	Economically viable and practically scalable solutions to address big bucket emission challenges.
Intermodal	Ideas for improvements such as freight, shuttle, and automation.
TCEQ Monitors	Worked with our community stakeholders and provided a formal letter for TCEQ in support of the stakeholder's initiatives of adding more air monitors in our Port communities.
Port Call Optimization (Synchronizer)	Decrease port turnaround times to have less vessel time and emissions at docks and anchorage via schedule transparency for terminals and vessels.
Regional CAP	City of Houston's CAP seeks to reduce regional GHG emissions
Flood Resiliency	Port Houston participates in the San Jacinto Regional Flood Planning Group to work on tangible ideas for flood resilience.

Storm Resiliency	Port Houston will participate in Coastal Risk Reduction and Resilience to focus on the implementation of an integrated approach to flood and coastal flood hazard mitigation.

Notes:

TCEQ	=	Texas Commission on Environmental Quality
MM	=	million
M/S/W	=	minority/small/women
PV	=	photovoltaic
Port	=	Port Houston
DERA	=	Diesel Emissions Reduction Act
TERP	=	Texas Emissions Reduction Plan
BBP	=	Buffalo Bayou Partnership
U.S.	=	United States
GHG	=	greenhouse gas
IEA	=	International Energy Agency
CAP	=	Climate Action Plan

Section 5. Emission Reduction Potential

As an economic engine, Port Houston has committed to leading by example, as well as supporting and celebrating the efforts made by its customers, tenants, and industry partners to reduce emissions. Port Houston plays a key role in managing mobile source emissions and has outlined where emission reductions are possible to set this course.

Emission Reduction Potential

The emission reduction strategies and tactics presented in Section 4 are viable options for reducing mobile source emissions at Port Houston terminals. The emission reduction potential of the strategies and tactics presented in Section 4 can vary and are dependent on the business decisions of industry partners. When evaluating potential emission reductions within the HDDV and CHE source categories, Port Houston took a pragmatic approach by analyzing the reductions that occurred between 2013 and 2019 and the potential for future reductions. Creating an emission reduction strategy that promotes the replacement of older equipment, building industry support and leveraging partnerships achieves the objectives within the *2021 CASP Update*.

Emission Reduction Targets

Since the 2007 GMEI was the first comprehensive GMEI that Port Houston developed, it is considered the baseline for comparisons to 2013 and 2019 updates. Reduction targets are set against the lowest values achieved to date, which occurred in both the 2007 and 2019 versions (2007 was the initial inventory, and corresponded to the lowest activity, and 2019 levels made the substantial improvements versus 2013 due to strategy implementations, despite higher activity). Thus, the targets below are set in context of both years.

The 2019 GMEI NOx total was 6,968 tons which is 4% above the 2007 NOx level of 6,716 tons, or near the same. For PM2.5 emissions, the 2019 total was 183 tons which is a 53% reduction from the 2007 PM2.5 total of 386 tons. As such, Port Houston by the end of 2026 aims to:

- Reduce NOx and PM2.5 by further 4% and 9% below 2019 levels
- Reduce the total NOx emissions to 25% lower than the 2007 baseline
- Reduce the total PM2.5 emissions to 75% lower than the 2007 baseline

Implementing the HDDV and CHE tactics under *Strategy #1* for Port Houston operated terminals has the potential to reduce total NOx emissions by 4.2% and total PM2.5 emissions by 9.1% from 2019.

Implementing the tactics under *Strategy #2* and *Strategy* #3 would be used for the additional NOx and PM2.5 emissions reductions needed to meet the total emission reduction goals of 25% lower NOx emissions compared to 2007 and 75% lower PM2.5 emissions compared to 2007.

Section 6. Evaluation and Reporting

Emission levels at Port Houston will ultimately be documented in periodic goods movement emission inventories. The status of the strategies and tactics described in Section 4 will be crucial to track progress toward Port Houston's emission reduction pursuits. As described in this section, Port Houston will implement systems to obtain, track, and report progress.

Tracking

The next scheduled GMEI will analyze emissions from Port operations in 2024 with further analyses occurring every 3 to 5 years. This enables the Port to utilize the scheduled roll out of emission inventories as a basis of comparison to evaluate the effectiveness of CASP strategies by 2027. These planned inventories also align with the *2021 CASP Update* goals and schedules. Enhanced tracking of equipment from each of the major source categories will allow for more streamlined emission reporting and allow Port Houston to track progress more accurately toward the CASP's emission reduction pursuits.

Data

Data quality is a key component and will be required to track progress toward the emission reduction pursuits outlined in Section 5. The following information will be needed to establish a framework for evaluating emission reduction strategies and tactics and the progress of PHA's emission reduction pursuits.

Reporting

Integral to the *2021 CASP Update* is Port Houston's commitment to transparency. Ongoing, public reporting will be performed to ensure the Port Commission (Commission) and Port stakeholders are well-informed about the progress being made. Outreach to the Commission will occur on the following schedule:

- Annually, to discuss prior year's results. Currently, these are planned for the second quarter; however, the schedule may change as data collection procedures evolve, or in years where emission inventories are under preparation.
- Whenever Port or terminal operations may have a recognized impact on the ability to meet goals.
- Whenever changes to the *2021 CASP Update* are proposed.
- In addition, many of the proposed *2021 CASP Update* measures will need Commission-approval to be implemented. Requests for Commission-approval will be accompanied with an assessment of the associated emission reductions, costs, and schedule for the proposed action. This includes:
    - Approval of grant agreements;
    - Capital expenditures (e.g., shore power and at-berth emission capture/control);
    - Tenant improvements (e.g., terminal lighting upgrades); and

- Operational/policy changes

It is Port Houston's intention to disseminate information regarding the *2021 CASP Update* to all interested parties on a dedicated webpage on the Port Houston website. Port Houston will also establish an electronic mailing list as a conduit to provide updates and related information for stakeholders.

APPENDIX A
AIR QUALITY POLLUTANTS

Appendix A. Air Quality Pollutants

Nitrogen Oxides (NOx)	NOx is a generic term for nitrogen oxides (NO and NO2; nitric oxide and nitrogen dioxide, respectively). In an internal combustion engine, combustion of a mixture of air and fuel produces temperatures high enough to yield various oxides of nitrogen. In areas of high motor vehicle traffic, such as in large cities, the amount of NOx emitted into the atmosphere can be quite significant. These oxides are poisonous, and can react with the oxygen in the air to produce ground level ozone and acid rain.
Particulate Matter (PM)	PM refers to tiny particles found in the air and can include dust, dirt, soot, smoke, and liquid droplets. Some PM is large and dark enough to be seen, such as soot and smoke; other particulate matter is so fine that it can be detected only with a microscope that examines air. PM is in emissions from cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, stone crushing, and burning wood. PM is formed indirectly when emissions from burning fuels -- especially emissions from motor vehicles, electric power plants, and other industrial processes -- react with sunlight and water vapor. It is also formed by grilling food on charcoal or gas, burning leaves and brush, and burning wood in a fireplace or wood stove.
Sulfur Dioxide (SO2)	SO2 is one of a group of highly reactive gasses known as “oxides of sulfur” and is linked with a number of adverse effects on the respiratory system. SO2 is a colorless gas with a pungent and suffocating odor, similar to a just-struck match. Most SO2 in the air comes from the burning of coal and oil at electric power plants. Other sources of sulfur dioxide in the air are industrial facilities that use coal or oil, petroleum refineries, cement

	manufacturing, metal processing, paper pulp manufacturing, and copper smelting. Trains, large ships, and some diesel equipment burn high sulfur fuel, which releases sulfur dioxide into the air.
Volatile Organic Compounds (VOCs)	VOCs are released from burning fuel, such as gasoline, wood, coal, or natural gas. They are also released from solvents, paints, glues, and other products that are used and stored at home and at work. Many volatile organic compounds are also hazardous air pollutants. VOCs when combined with NOx react to form ground-level ozone, or smog, and contribute to climate change. Examples of VOCs are gasoline, benzene, formaldehyde, solvents such as toluene and xylene, and perchloroethylene (or tetrachloroethylene), the main solvent used in dry cleaning. Many volatile organic compounds are commonly used in paint thinners, lacquer thinners, moth repellents, air fresheners, hobby supplies, wood preservatives, aerosol sprays, degreasers, automotive products, and dry cleaning fluids.
Carbon dioxide (CO2)	CO2 is colorless, and acts as an asphyxiant and an irritant and is considered very unhealthy at levels above 5,000 ppm. CO2 is produced by burning fossil fuels, such as coal, oil, gasoline, and natural gas, used for electricity generation, transportation vehicles, cement, or lime manufacturing, waste burning, and natural gas flaring. Uses of CO2 include refrigeration, carbonation, and production of other chemicals such as fertilizers, aerosol propellants, aspirin, and inflating devises. In the atmosphere, CO2 is part of the global carbon cycle between the atmosphere, oceans, land, marine life, and mineral reservoirs. Considered a "greenhouse gas" because CO2 absorbs heat in the atmosphere, sending some of the

	absorbed heat back to the surface of the earth and contributing to climate change.
Carbon Monoxide (CO)	CO is a colorless, odorless, and tasteless gas which is highly toxic to humans and animals in higher quantities CO is produced by the incomplete burning of natural gas, gasoline, liquefied petroleum gas, oil, kerosene, coal, charcoal, or wood. Sources of CO include unvented kerosene and gas space heaters; leaking chimneys and furnaces; gas stoves; back-drafting from furnaces, gas water heaters, fireplaces and engine exhaust. CO is used to separate metals from their ores and make other chemicals, including phosgene and is used in blast furnaces.

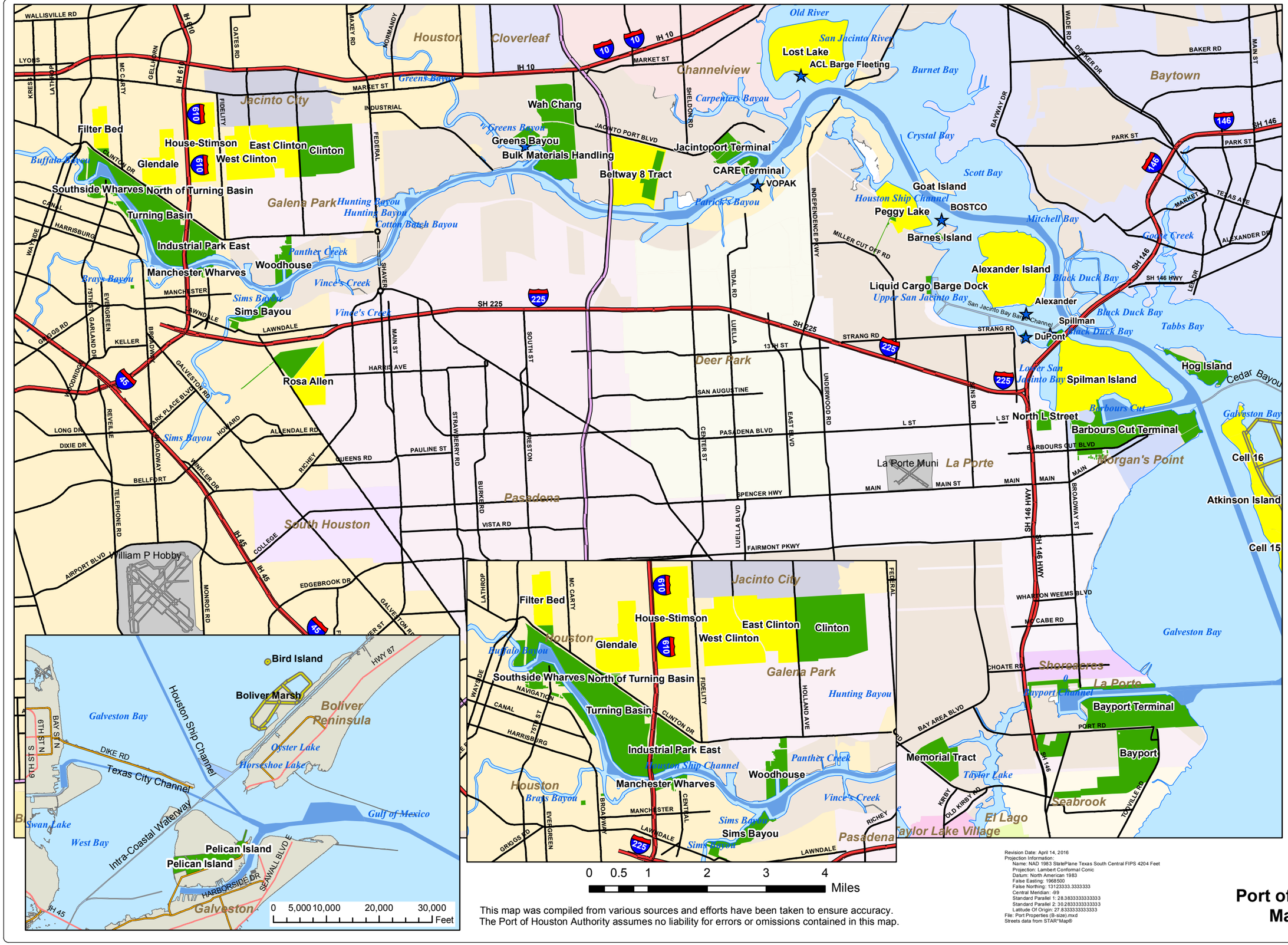
APPENDIX B
EMISSION SOURCE CATEGORIES

Appendix B. Emission Source Categories

Ocean Going Vessels	Ocean Going Vessels (OGVs) calling at port terminals are the largest emissions sources at the Port. Types of OGVs visiting the Port include auto carriers, RoRo (roll on/roll off vessels), reefer (refrigerated vessels), tankers, and general cargo vessels. Marine fuel combustion in the onboard OGV propulsion engines, auxiliary engines, and auxiliary boilers is the source of the emissions generated in OGVs. OGVs contribute significantly to air pollution, primarily in the form of SO2, PM, and NOx. Pollution from OGVs is primarily due to fuel, called "bunker fuel" which is high in SO2 and used globally.
Harbor Vessels	Harbor craft are commercial vessels that operate mostly within or near a port. Harbor craft working in the Port include tugboats, commercial fishing vessels, charter fishing vessels, as well as crew and supply boats. The harbor craft use both propulsion and auxiliary engines in routine operations. Exhausts from onboard main (propulsion) engines, auxiliary engines, and auxiliary boilers are the source of the emissions associated with harbor craft.
Cargo Handling Equipment	Cargo handling equipment (CHE) is equipment used to move cargo (containers, general cargo, and bulk cargo) to and from marine vessels, railcars, and on-road trucks. CHE includes cranes, yard tractors, top and side handlers, forklifts, and other related equipment found in smaller quantities such as loaders, sweepers, backhoes, aerial platform lifts, and generator sets. The equipment typically only operates at marine terminals or at rail yards and does not operate on public roadways. CHE can be diesel, gasoline, alternative fuel, or

	electrically powered. Fuel combustion is the source of emissions from this equipment. Although this equipment is not a large emissions source in the Port, these emissions are generated in proximity to workers and the local community.
Locomotives	Railroad operations are typically described in terms of two different types of operation, line haul and switching. Line haul refers to the movement of cargo over long distances (e.g., cross-country) and occurs within the Port as the initiation or termination of a line haul trip, as cargo is either picked up for transport to destinations across the country or is dropped off for shipment overseas. Switching refers to the assembling and disassembling of trains at various locations in and around the Port, sorting of the cars of inbound cargo trains into contiguous "fragments" for subsequent delivery to terminals, and the short distance hauling of rail cargo within the Port. The Port Terminal Railroad Association provides the switching operation at the Port and BNSF Railway, Union Pacific, and Kansas City Southern Railroad provide long haul service at the Port.
Heavy Duty Trucks	Heavy-duty drayage trucks are diesel-fueled trucks that transport marine cargo, containers, or transport chassis. Refrigerated trailers, built to accommodate the transfer of refrigerated cargo, are the most common type of tractor trailers at the Port. Diesel fuel combustion in truck engines is the source of emissions generated in heavy-duty drayage trucks. Trucks are the second largest source of emissions at the Port.

APPENDIX C
MAP OF PORT HOUSTON AUTHORITY PROPERTIES



Legend

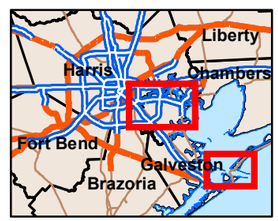
- Lease Submerged Lands
- Offshore Dredge Material Levee
- Ship Channel
- Shallow Channels and IntraCoastal
- Dredged Material Placement Areas
- Port of Houston Authority Property

Street Type

- Freeway
- Tollway
- Major
- Tunnel

N W E S

Location Map



This map was compiled from various sources and efforts have been taken to ensure accuracy.
The Port of Houston Authority assumes no liability for errors or omissions contained in this map.

Revision Date: April 14, 2016
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Streets data from STAR*Map®

Port of Houston Authority Map of Properties

APPENDIX D
NORTH AMERICAN SEAPORT AIR QUALITY BMP REVIEW

North American Seaport Air Quality BMP Review					
Program	**V. brief description**	**Date Implemented or Planned**	**Port**	**Emissions Source**	**Program Type**
Awareness about reducing emissions	And influence new purchases to include equipment up to highest emission standards.	2009 - 2010	Port of NY & NJ	Harbor Vessels	BMP / Educational Policies
Clean Ship/Green Flag Program	Used to track ESI.	2009 - 2014	Port of NY & NJ	Ocean Going Vessels	BMP / Educational Policies
Cold Weather Idling pilot program	Consider actions and pilot Program to work through technical issues.	"Future"	Port of NY & NJ	Cargo handling equipment	BMP / Educational Policies
Environmental Ship Index (ESI)	Establishing criteria for evaluating and recognizing clean ships.	2009	Port of NY & NJ	Ocean Going Vessels	BMP / Educational Policies
Evaluation of alternative power	hybrid, CNG, Electric - lifting equipment at intermodal yards.	2011 - 2014	Port of NY & NJ	Locomotives	BMP / Educational Policies
Explore options - reducing fuel costs	For cost of cleaner / alternative fuels for harbor craft (bulk suppliers, and tax incentives)	"Future"	Port of NY & NJ	Harbor Vessels	BMP / Educational Policies
Lobbying - tax exemption repeal	NYCEDC to seek to repeal the NY State tax exemption for bunker fuel.	2009	Port of NY & NJ	Ocean Going Vessels	BMP / Educational Policies
Move goods by rail or barge - incentive program	NYCEDC negotiated a lease agreement at South Brooklyn Marine Terminal with Axis, which includes financial incentives for moving goods by rail or barge	2009	Port of NY & NJ	Locomotives	BMP / Educational Policies
North American Emissions Control Area support	Led by EPA R2 helping advance the agency work needed to submit and support the ECA application process.	2009	Port of NY & NJ	Ocean Going Vessels	BMP / Educational Policies
NYCEDC Study	Freight movement, modal splits, and short sea shipping	2009	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
On-Terminal Idling study	Determine cause of idling by CHE and work to strengthen Idle Reduction Program	2009	Port of NY & NJ	Cargo handling equipment	BMP / Educational Policies
Partnerships with other ports	To implement clean ship and other related programs	2009 - 2014	Port of NY & NJ	Ocean Going Vessels	BMP / Educational Policies
Post-combustion controls and after-treatment technology	Investigate and test for tugs.	2010 - 2012	Port of NY & NJ	Harbor Vessels	BMP / Educational Policies
Public-private partnerships	For Retrofits and/or alternative fuels.	2009 - 2014	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
Test Hydraulic and Electric Hybrid Yard Holsters	Sponsor pilot project to do so.	2009 - 2011	Port of NY & NJ	Cargo handling equipment	BMP / Educational Policies
Truck Replacement Program	Phase out older trucks (pre 1994 to 2004 or newer)	2010 - 2017	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
Anti-idling technology	install in switcher locomotive engines	2009 -2010	Port of NY & NJ	Locomotives	Equipment Upgrade

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Cross-harbor rail barge	And convert locomotive switcher engines supporting the operation to GenSet config and implement ULSD in both	2009 - 2014	Port of NY & NJ	Harbor Vessels	Equipment Upgrade
Decommission or Electrify Cranes	Decommission 2 diesel cranes and upgrade 9 to electric	2009 - 2014	Port of NY & NJ	Cargo handling equipment	Equipment Upgrade
Diesel Oxidation Catalysts on Ferries	Install on private ferries	2009 - 2014	Port of NY & NJ	Harbor Vessels	Equipment Upgrade
Diesel Particulate Filters (DPF)	Installed and evaluated DPF on yard tractors	2009	Port of NY & NJ	Cargo handling equipment	Equipment Upgrade
Efficiency Improvements	Such as electrification of lift equipment, alternative power, etc.	"Future"	Port of NY & NJ	Locomotives	Equipment Upgrade
Electric Cranes	Electric cranes and modernization of all CHE at container terminals to models meeting EPA's 2004 on-road emissions standards.	2009	Port of NY & NJ	Cargo handling equipment	Equipment Upgrade
Engineer retrofits / replacements	Staten Island Ferries and tugs	2009	Port of NY & NJ	Harbor Vessels	Equipment Upgrade
Engineer retrofits / replacements (MERP)	Expand program to private ferries, tugs, and other harbor crafts.	2009 - 2014	Port of NY & NJ	Harbor Vessels	Equipment Upgrade
Finance acquis ion of trucks	Port truck owners finance acquisition of newer, lower emitting vehicles.	2009 - 2012	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Ground Air System	Replace on-board air compressor (diesel powered)	2009	Port of NY & NJ	Locomotives	Equipment Upgrade
Idle Reduction Program	Restrict idling times of diesel powered CHE through automatic shutoff devices and electric plug-in technology.	2009	Port of NY & NJ	Cargo handling equipment	Equipment Upgrade
Marine Vessel Engine Replacement Program	Tier I, II or III marine engines	2009	Port of NY & NJ	Harbor Vessels	Equipment Upgrade
Modernize / upgrade / decommission CHE	up to 300 pieces of CHE (including 50 of oldest engines) - meet EPA's 2007 on-road standards	2009 - 2014	Port of NY & NJ	Cargo handling equipment	Equipment Upgrade
New Engines with DPF - cranes	Total of 4 wharf cranes	2010	Port of NY & NJ	Cargo handling equipment	Equipment Upgrade
NYCEDC truck upgrade (100 trucks)	Phoenix Beverages fleet upgrade to CNG within 7 years	2010	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Reconfigure engines	Two switching locomotive engines with GenSet	2010 - 2011	Port of NY & NJ	Locomotives	Equipment Upgrade
Replace / Upgrade all remaining CHE	Using best available technology	"Future"	Port of NY & NJ	Cargo handling equipment	Equipment Upgrade

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Replace 1/3 CHE Fleet	Of all PA leased terminals with alternative powered equipment (including hydraulic hybrids, CNG, etc.)	2009 - 2014	Port of NY & NJ	Cargo handling equipment	Equipment Upgrade
Retrofit / Replace Locomotives	UP to 3 switching locomotives	2009 - 2010	Port of NY & NJ	Locomotives	Equipment Upgrade
Accelerate use of ULSD fuel	In advance of EPA's 2012 non-road diesel standards.	2009 - 2011	Port of NY & NJ	Harbor Vessels	Fuel upgrade
CNG, Propane or electric powered forklifts	For Warehouse	2009	Port of NY & NJ	Cargo handling equipment	Fuel upgrade
ILSD fuel switch	Fuel switch in switcher locomotives service Port and in CHE	2009 - 2012	Port of NY & NJ	Locomotives	Fuel upgrade
Incentive program for low-sulfur fuel	Incentive program to switch to low sulfur fuel when in ports	2009 - 2012	Port of NY & NJ	Ocean Going Vessels	Fuel upgrade
Smart Way partnership	Enhance business to truckers using Stairway air emission and fuel efficiency upgrades.	2009 - 2010	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	Fuel upgrade
Switchover to ULSD	In all harbor craft, including Staten Island Ferries.	2009	Port of NY & NJ	Harbor Vessels	Fuel upgrade
ULSD switchover	Completed switchover to use ultra-low sulfur diesel fuel in all CHE.	2009	Port of NY & NJ	Cargo handling equipment	Fuel upgrade
Electrify 9 new cranes	Upgrade wharf power infrastructure to support 9 new electric cranes.	2009 - 2014	Port of NY & NJ	Cargo handling equipment	Infrastructure Upgrade
Expanded rail capacity	Extending and modernizing the Staten Island RR	2009	Port of NY & NJ	Locomotives	Infrastructure Upgrade
Express Rail Expansion	Establish on-dock rail at all container terminals.	2007	Port of NY & NJ	Locomotives	Infrastructure Upgrade
Extend and Modernize rail lines	increase efficiency.	2009 -2011	Port of NY & NJ	Locomotives	Infrastructure Upgrade
Kim Hot Start	Anti-idling device on an on-dock switcher locomotive at NY Container Terminal.	2009	Port of NY & NJ	Locomotives	Infrastructure Upgrade
Near Port Truck Parking	With Electrification technology to reduce emissions and other amenities to encourage use.	"Future"	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	Infrastructure Upgrade
New Exit Ramp / Port-Only Lane	Off NJ Turnpike for Port traffic only	"Future"	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	Infrastructure Upgrade
NY/NH Roadway Enhancement	Increase roadway capacity and reduce congestion	2009 or before	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	Infrastructure Upgrade
Plug-ins for Refrigerated Containers	Install plug-ins at NYC marine terminal and Hunts Point	"Future"	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	Infrastructure Upgrade
Shore Power	"cold ironing"	2009 - 2011	Port of NY & NJ	Ocean Going Vessels	Infrastructure Upgrade

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Strong-arm dockers on ferries	Enable them to shut off engines while picking up or discharging passengers at dock.	"Future"	Port of NY & NJ	Harbor Vessels	Infrastructure Upgrade
Wind Turbines	At Port Authority facilities.	"Future"	Port of NY & NJ	Cargo handling equipment	Infrastructure Upgrade
Appointment system	For trucks serving terminal, fast lane for 2004 or younger trucks	2010	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
Automatic Identification System (AIS)	monitor incoming vessel speeds and plan just in time arrival	2009 -2011	Port of NY & NJ	Harbor Vessels	Operating Procedure Update
Identify Tug tie up and shut down locations	As part of NYC EDC's Phase II Maritime Support Study	2009 - 2011	Port of NY & NJ	Harbor Vessels	Operating Procedure Update
Locomotive shut down	Operational procedure to shut down engines when not in use and outside temperatures permit.	2009	Port of NY & NJ	Locomotives	Operating Procedure Update
Long Term operational Change	Increase amount of cargo leaving port on rail vs. truck	"Future"	Port of NY & NJ	Locomotives	Operating Procedure Update
NYSA Rail Incentive Program	NYSA created rail incentive program in July 2007	2007	Port of NY & NJ	Locomotives	Operating Procedure Update
Reduce truck dependency / Use Rail	Enhance use of rail and barge: Express Rail expansion, short haul rail lines, short sea shipping	"Future"	Port of NY & NJ	Locomotives	Operating Procedure Update
Shipping Line Rule Change	Change operating rules for chassis pool so they are more effective.	"Future"	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
Terminal Operators upgrades	Electric gates, relocated gates, and extended gate hours	2009 or before	Port of NY & NJ	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
Vessel assignment planning	Reduce transit length	2009 -2011	Port of NY & NJ	Harbor Vessels	Operating Procedure Update
Vessel Speed Incentive Program	Year-round program for ships approaching harbor.	2009-2012	Port of NY & NJ	Ocean Going Vessels	Operating Procedure Update
Vessel Speed Reduction	Increase fuel efficiency	2009 -2011	Port of NY & NJ	Harbor Vessels	Operating Procedure Update
Anti-Idling Policy and Enforcement for CHE	Working with stakeholders, (construction contractors, tenants, and operations) develop and implement anti-idling policies.	Ongoing	Port of Houston	Cargo handling equipment	BMP / Educational Policies
Anti-Idling Policy for Region	Work with the City of Houston and Harris County, to develop and implement an anti-idling policy in order to expedite and enhance the message to customers and community.	Ongoing	Port of Houston	Cargo handling equipment	BMP / Educational Policies
Centerpoint Hybrid Yard Tractor	Demonstrated a hybrid system retrofitted yard tractor.	Ongoing	Port of Houston	Cargo handling equipment	BMP / Educational Policies

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Clean Fleet Policy for Contractors	Extend the Clean Fleet Policy to construction contractors.	Ongoing	Port of Houston	Cargo handling equipment	BMP / Educational Policies
Clean Fleet Policy Program	Continue to develop and implement the Clean Fleet Policy for PHA and all operator/tenants to encourage fleet turnover in an accelerated manner through the use of private funds or grants.	Ongoing	Port of Houston	Cargo handling equipment	BMP / Educational Policies
CNG Yard Tractor Demonstration	„Capacity™“ CNG yard tractor was demonstrated at BCT. Results were mixed: drivers noted it would not also be able to operate a full shift.	Ongoing	Port of Houston	Cargo handling equipment	BMP / Educational Policies
Educational/Outreach Program	Educate tenants on potential grant programs and provide outreach in terms of grant-writing and exploration of additional funding programs for CHE replacement.	Ongoing	Port of Houston	Cargo handling equipment	BMP / Educational Policies
Public / Private Partnerships	Developed partnerships with 4 private entities in order for PHA to apply as the public entity for federal funding. The development of partnerships is an on-going CASP action item.	2011	Port of Houston	Cargo handling equipment	BMP / Educational Policies
TERP for Construction Project Equipment	Develop an education/outreach program specifically to construction contractors to educate them on funding programs.		Port of Houston	Cargo handling equipment	BMP / Educational Policies
Diesel Electric Hybrid Yard Tractor	first commercially available diesel electric hybrid yard tractor. The yard tractor is battery operated with a small diesel engine.	2009	Port of Houston	Cargo handling equipment	Equipment Upgrade
Grant Administration	PHA was awarded over $600,000 in DERA grant funds to replace 14 yard crane engines with new, cleaner tons of NOx.	2011	Port of Houston	Cargo handling equipment	Equipment Upgrade
Investigate incentive programs	to retire tenants“ CHE fleet	Ongoing	Port of Houston	Cargo handling equipment	Equipment Upgrade
New Purchases	9 new RTG with fuel saving technology and anti-idling	Ongoing	Port of Houston	Cargo handling equipment	Equipment Upgrade
Pass thru-Grants	PHA acts as an agent for the implementation of $3.4 million dollars to repower or replace over 157 older diesel engines for tenants and users,	2009	Port of Houston	Cargo handling equipment	Equipment Upgrade
Policy Modifications	Explore possible lease modifications to encourage fleet turnover	Ongoing	Port of Houston	Cargo handling equipment	Equipment Upgrade

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Yard Tractor Electrification Demonstration	Electrification of trucks and yard tractors at Bayport, for example, may be considered.		Port of Houston	Cargo handling equipment	Equipment Upgrade
Fueling Policy for Tenants/Contractors	Establish fueling policy for the entire fleet, tenants, and contractors to only operate on TxLED On-Road Diesel for all CHE.		Port of Houston	Cargo handling equipment	Fuel upgrade
Electrical Power Infrastructure	Install/upgrade electric infrastructure to support electrification of - PHA Barbour Cut - wharf cranes	Ongoing	Port of Houston	Cargo handling equipment	Infrastructure Upgrade
Bayport Terminal Permit Commitment	As part of the permit with the Corp of Engineer's PHA committed to use clean fuel and clean engine technology PHA Bayport Terminal to help reduce air emissions.	2011	Port of Houston	Cargo handling equipment	Operating Procedure Update
Fueling Policy for PHA Fleet	PHA established and implemented a fueling policy to purchase the cleanest on-road fuel available for equipment and vehicles.	Ongoing	Port of Houston	Cargo handling equipment	Operating Procedure Update
Education / Outreach for Harbor Vessels	Develop a working group of stakeholders, (harbor craft owners) to ensure that vessels used in the Houston Ship Channel are repowered with engines that meet the cleanest engine standards and that vessels are using the cleanest diesel fuel available in the area prior to EPA regulatory dates.	Ongoing	Port of Houston	Harbor Vessels	BMP / Educational Policies
Marine Engine Rule	Support policy for the implementation of the Marine Engine Rule	Ongoing	Port of Houston	Harbor Vessels	BMP / Educational Policies
New Technology Demonstration	Encourage the demonstration and implementation of advanced technology systems	2011	Port of Houston	Harbor Vessels	BMP / Educational Policies
TWOA MOA	Supported TWOA MOA for emission reduction in HGB area.	2011	Port of Houston	Harbor Vessels	BMP / Educational Policies
Scrubber Technology for Harbor Vessels	Evaluate scrubber technology for tugboats and/or dredges.	Ongoing	Port of Houston	Harbor Vessels	Equipment Upgrade
Fueling Policy for Tugboats/Dredges	Tugs, towboats and dredges using on-road TxLED instead of off-road TxLED in advance of the regulations.	2012	Port of Houston	Harbor Vessels	Fuel upgrade
Hybrid Tugboat Demonstration	Demonstrate the viability of a hybrid tugboat.	Ongoing	Port of Houston	Harbor Vessels	Fuel upgrade

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Education/Outreach for Drayage Trucks	This measure includes an education/outreach program to drayage truck owners/operators.	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
Anti-Idling	Determine the causes of on-terminal idling by Trucks	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
Speed Limit Enforcement	PHA will work with Port terminals to set and enforce speed limits within the terminals for on-road vehicles.	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
Stage II Vapor Recovery System	PHA will evaluate re-fueling vapor recovery systems.	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
Stakeholder Involvement	Established a quarterly truck policy working group to develop and review strategic recommendations for PHA and tenant operations.	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
HDDV Bridge Loan Program Facilitation.	This innovative financing project was developed through a collaborative process that included PHA, H-GAC, Environmental Defense Fund, the University of Texas Center for Transportation Research, and Emisstar LLC.	2009	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Smart Way Drayage Truck Program	PHA committed $50,000 towards the EPA Smart Way Program in the HGB area	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Electrification	Consider near-Port truck parking areas with plug-in electrification technology to reduce idling emissions and rest stop amenities	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
H-GAC Drayage Truck PEMS study	In January and March of 2010, EPA and contractors installed PEMS and PAMS units on drayage trucks that serve Barbours Cut and Bayport to collect data and ride with drivers.	2010	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
Operations / Logistics	Consider an appointment system for trucks serving the terminals, including a fast lane at the gate for newer (2004 or younger) vehicles, in order to decrease total truck turnaround time	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Regional Anti-Idling Policy	Evaluate effectiveness and practicality of creating a regional anti-idling policy with the City of Houston, Harris County, the City of Pasadena, etc. Consider actions to address problems with hot weather idling and creep idling	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
TERP Policy for Tenant Trucks	Evaluate a policy requiring a certain percentage of tenant trucks be upgraded through TERP or other means.	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
Texas Emission Reduction Program	Supported the start and funding of the TERP to help the HGB region meet the clean air goals of the State Implementation Plan (SIP).	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
Truck Program Collaboration	Evaluate effectiveness of collaborating with other truck programs and/or broadening scope of truck program.	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
Truck Registry	Maintain a data base of trucks (manufacturer and year) of trucks entering the PHA	Ongoing	Port of Houston	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
Locomotive Engine Replacement	Evaluate the feasibility of an engine replacement schedule for locomotives – a five to ten-year plan in accordance with the EPA ruling.	2011	Port of Houston	Locomotives	Equipment Upgrade
Fueling Policy for Locomotives	Switching lines using on-road TxLED instead of off-road TxLED. Actual fuel usage with would be reviewed with line haul operators to determine whether they use TxLED, as no credit for TxLED was given in GMEI.	2011	Port of Houston	Locomotives	Fuel upgrade
Verification of Ener-Burn™ Fuel Additive	Support the EPA and/or CARB in the verification of Ener-Burn™ to establish emission reduction percentages. PTRA uses Ener-Burn™ a fuel additive which eliminates engine deposits and increases fuel efficiency.	2011	Port of Houston	Locomotives	Fuel upgrade
Anti-Idling Devices on Switcher Engines	Automatic shutdown devices installed in all switch engines to eliminate idling time longer than 15 minutes.	2011	Port of Houston	Locomotives	Operating Procedure Update

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Collaboration with AAPA, EPA and National Rail Lines	collaboration with AAPA and/or EPA, PHA would reach out to the national rail lines, BNSF, UP and KCS, to identify existing control measures, and to support additional control measures.	2011	Port of Houston	Locomotives	Operating Procedure Update
C40 Climate Leadership Group	C40 World Ports Conference in Rotterdam.	2008	Port of Houston	Ocean Going Vessels	BMP / Educational Policies
Collaboration with High Frequency Shipping Lines	PHA will initiate and establish collaboration with frequent shipping operators to jointly develop emission reduction strategies for OGVs.	Near Future	Port of Houston	Ocean Going Vessels	BMP / Educational Policies
Demonstrations	Demonstrate the use of new technologies and alternative fuels, for example; an LNG-fuel container vessel at berth.	Near Future	Port of Houston	Ocean Going Vessels	BMP / Educational Policies
Fuel Switch Study with EPA's International Project Office	Show effectiveness of OGVs using lower sulfur fuels. Sulfur Marine Gas Oil to replace Heavy Fuel Oil.	2009 - 2010	Port of Houston	Ocean Going Vessels	BMP / Educational Policies
North America ECA (Emission Control Areas)	ECA - The PHA, along with EPA"s Office of International Affairs, is encouraging Mexico to join the North American ECA in the near future.	Near Future	Port of Houston	Ocean Going Vessels	BMP / Educational Policies
Shore Power for Cruise Ships - Demonstration	PHA will assess the use of shore power for future cruise ships at the new Bayport Cruise Terminal. Currently, the Bayport Cruise Terminal is currently has no long term cruise ship services.	Near Future	Port of Houston	Ocean Going Vessels	BMP / Educational Policies
Vessel Speed Reduction from Buoy to International Waters	This measure would have ships slow their speed approximately 20 miles from the entrance to the HSC; emissions for this area were outside the scope of the GMEI.	Near Future	Port of Houston	Ocean Going Vessels	BMP / Educational Policies
Vessel Speed Reduction in Houston Ship Channel	Evaluate the feasibility and effectiveness for emission reductions to further decrease speed of OGVs within the HSC	Near Future	Port of Houston	Ocean Going Vessels	BMP / Educational Policies
Advanced Maritime Emission Control System (AMEC®)	AMEC is a barge- or dock-based system designed to capture and treat, using Selective Catalytic Reduction (SCR), exhaust emissions while OGVs are at anchorage waiting to be berthed, and at berth.	Near Future	Port of Houston	Ocean Going Vessels	Equipment Upgrade

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Diesel Emission Reduction Act DERA -	Replace, repower and retrofit over 165 pieces of old diesel equipment owned by PHA.	2011 or before	Port of Houston	Ocean Going Vessels	Equipment Upgrade
Study Shore Power at PHA Terminals	Determine whether the type and frequency of individual OGVs at Barbours Cut, Bayport, and Jacintoport Terminals are sufficient in number to make shore power feasible. Conduct a cost-benefit analysis.	Near Future	Port of Houston	Ocean Going Vessels	Infrastructure Upgrade
Update Emissions Inventory	On 5-year intervals.	2008, 2013	Port of Hueneme	Other	BMP / Educational Policies
Maintain Drayage Truck Compliance	The statewide Drayage Truck Regulation was approved by the CARB to reduce emissions from drayage trucks transporting cargo to and from California's ports and intermodal rail yards.	2013	Port of Hueneme	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
Maintain Shore-Side Power Project Compliance and Reporting	The California At-Berth Ocean-Going Vessels regulation has been established for at-berth emission reductions from auxiliary engines onboard OGV by utilizing grid-based shore power systems or other achievable equivalent emission reduction strategies.	2011	Port of Hueneme	Ocean Going Vessels	Infrastructure Upgrade
Develop Terminal Equipment Upgrade Program	Replacing, repowering, or retrofitting terminal equipment	2013	Port of Hueneme	Cargo handling equipment	Equipment Upgrade
Design and Implement an Environmental Management Information System	An EMIS will store, process, and track key environmental data while reducing overall management costs.	2013 - ongoing	Port of Hueneme	other	BMP / Educational Policies
Pursue Grant Funding	A wide range of federal, state and local grant programs provide opportunities to secure funding for implementation of replacement, repower or retrofit projects in advance of regulatory requirements.	2013 - ongoing	Port of Hueneme	other	BMP / Educational Policies
Green Lease Program	Lease negotiation offers the opportunity for the Port to negotiate and require specific air emission control measures to be included in a lease agreements.	2013 - ongoing	Port of Hueneme	Other	BMP / Educational Policies

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Technology Advancement Program	Port-funded incentive programs will be one of the long-term, ongoing emission reduction measures to be implemented at the Port when funding (including grant funding) becomes available.	2013 - ongoing	Port of Hueneme	Other	BMP / Educational Policies
Technology Advancement Program	Port-funded incentive programs will be one of the long-term, ongoing emission reduction measures to be implemented at the Port when funding (including grant funding) becomes available.	2013 - ongoing	Port of Hueneme	Cargo handling equipment	BMP / Educational Policies
Technology Advancement Program	Port-funded incentive programs will be one of the long-term, ongoing emission reduction measures to be implemented at the Port when funding (including grant funding) becomes available.	2013 - ongoing	Port of Hueneme	Harbor Vessels	BMP / Educational Policies
Adoption of CAAP	by LA and LB in Nov. 2006	Nov-06	Port of LA / Long Beach	Other	BMP / Educational Policies
Air Emissions Inventory	Annual updates	2007, 2008, 2009, 2010	Port of LA / Long Beach	Other	BMP / Educational Policies
Air Monitoring Network	Real-time air monitoring website	2006 - 2008	Port of LA / Long Beach	Other	BMP / Educational Policies
CAAP Air Quality Awards	Annual program with award ceremonies	2008, 2009, 2010	Port of LA / Long Beach	Other	BMP / Educational Policies
CAAP Implementation Stakeholder Task Force	City's Mayor's office task force to provide input for CAAP Implementation plan.	2007	Port of LA / Long Beach	Other	BMP / Educational Policies
Green Flag Program / Vessel Speed Reduction Incentive Program	Long Beach - GFP, LA - VSR to 20nm and 40nm	2005-2010	Port of LA / Long Beach	Ocean Going Vessels	BMP / Educational Policies
Technology Advancement Program -	The mission of the TAP is to accelerate the verification and commercial availability of new, clean technologies, through evaluation and demonstration.	2007 - 2010	Port of LA / Long Beach	Other	BMP / Educational Policies
Vessel Main Engine Fuel Incentive Program	monetary incentives for low-sulfur marine gas oil (MGO)	2009	Port of LA / Long Beach	Ocean Going Vessels	BMP / Educational Policies
Website	www.cleanairactionplan.org	Copyright - 2000 - 2016	Port of LA / Long Beach	Other	BMP / Educational Policies
Clean Truck Program - 2007 USEPA On-Road Standards	over half of all truck trips met 2007 US EPA on-road standards	2009	Port of LA / Long Beach	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Clean Truck Program - Zero Emissions Trucks	25 Electric trucks operating with advanced lithium ion battery systems	2009 - 2010	Port of LA / Long Beach	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Foss Maritime Green Assist Hybrid Tug	Completed in first year of operation. Emissions testing "underway"	2010?	Port of LA / Long Beach	Harbor Vessels	Equipment Upgrade
Pacific Harbor Line	Replacement of fleet with EPA Tier 2 locomotives	2008 -2009	Port of LA / Long Beach	Locomotives	Equipment Upgrade
POLA Air Quality Mitigation Incentive Program	Repower 53 main and auxiliary marine engines	2010?	Port of LA / Long Beach	Harbor Vessels	Equipment Upgrade
SCAQMD's Carl Moyer Program	repower 92 main and auxiliary engines	2010?	Port of LA / Long Beach	Harbor Vessels	Equipment Upgrade
USEPA Diesel Emissions Reduction Act Funds	Repower 14 engines onboard two crew boats, two tug boats and two pilot boats	2010?	Port of LA / Long Beach	Harbor Vessels	Equipment Upgrade
Clean Truck Program - LNG power	Clean Energy Fuel Corp constructed LNG fueling facility near port area.	2009 - 2010	Port of LA / Long Beach	Heavy Duty Diesel Fueled On-Road Vehicles	Fuel upgrade
Ultra-low Sulfur Diesel for Class 1	For switcher and helper locomotives	2007	Port of LA / Long Beach	Locomotives	Fuel upgrade
Shore Power Infrastructure	At container, cruise and tanker terminals	2009 - 2014	Port of LA / Long Beach	Ocean Going Vessels	Infrastructure Upgrade
Clean Truck Program - ban on older trucks	Ban oldest pre-1989 model year	2008	Port of LA / Long Beach	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
Clean Truck Program - Tariff / Fee	Tariff and Fee programs	2007 - 2008	Port of LA / Long Beach	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
Clean Truck Program - Truck Environmental Fee & Drayage Truck Registry	initiated for all non-exempt trucks and all trucks in port required to be registered with DTR	2009	Port of LA / Long Beach	Heavy Duty Diesel Fueled On-Road Vehicles	Operating Procedure Update
Auxiliary engine low sulfur fuel rule	Requires low sulfur fuel for use with auxiliary engines.	2007	Port of Oakland	Ocean Going Vessels	Fuel upgrade
Main Engine, auxiliary engine and boiler low sulfur fuel rule	Requires low sulfur fuel for use with vessel main engines, auxiliary engines and boilers.	2009	Port of Oakland	Ocean Going Vessels	Fuel upgrade
Cold Ironing Rule	Control hoteling emissions via one of several possible methods.	2009	Port of Oakland	Ocean Going Vessels	BMP / Educational Policies
Vessel Speed Reduction	Evaluating need for VSR measure at major ports and along coastline.	2009	Port of Oakland	Ocean Going Vessels	Operating Procedure Update
Clean Ship Program	Evaluating measure or incentive program to require cleaner or retrofitted vessels in CA ports	"under consideration"	Port of Oakland	Ocean Going Vessels	BMP / Educational Policies
New marine compression-ignition (diesel) engine rule	National exhaust emission standards for new engines at or above 30 liters per cylinder ("category 3" marine diesel engines)	2003-2016	Port of Oakland	Ocean Going Vessels	BMP / Educational Policies
MARPOL Annex VI Tier 2 and Tier 3 engine emission standards	Any engine > 130kW installed on a vessel constructed on or after 1/1/2000 and any engine that undergoes a major conversion on or after 1/1/2000.	2008-2016	Port of Oakland	Ocean Going Vessels	Equipment Upgrade

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
MARPOL Annex VI Tier 1 NOx standard	Any engine > 130kW installed on a vessel constructed on or after 1/1/2000 and any engine that undergoes a major conversion on or after 1/1/2000.	2008-2010	Port of Oakland	Ocean Going Vessels	Equipment Upgrade
Commercial Marine Diesel Engine emission standards: Tier 1 & 2	New engine standards for Category 1 & 2 marine diesel engines	2004-2007	Port of Oakland	Harbor Vessels	Equipment Upgrade
Marine Diesel Engine Rule: Tier 3 & 4	Affects engines up to 30 liters per cylinder; relies on catalytic after treatment technologies with less than 15 ppm sulfur fuel. (This rule is coupled with the locomotive Tier 3 & 4 exhaust standards.)	2008-2014	Port of Oakland	Harbor Vessels	Equipment Upgrade
ARB Harbor Craft low sulfur fuel rule	Requires Ultra-low Sulfur Diesel (ULSD) fuel use in harbor craft	2006-2007	Port of Oakland	Harbor Vessels	Fuel upgrade
ARB In-Use Harbor Craft rule	Reduce PM and NOx from in-use ferries, tugs, tows and new commercial harbor craft	2009-2022	Port of Oakland	Harbor Vessels	BMP / Educational Policies
ARB Crew and Supply Vessel rule	Similar to in-harbor craft rule	"under consideration"	Port of Oakland	Harbor Vessels	BMP / Educational Policies
ARB Cargo Handling Equipment regulations	Retrofit or accelerated turnover to meet Best Available Control Technology (BACT) for newly purchased, leased or rented equipment (2007 or later on-road engine or Tier 4 off-road engine or cleanest verified PM/NOx retrofit)	2007	Port of Oakland	Cargo handling equipment	Equipment Upgrade
EPA non-road and ARB off-road diesel engine standards	Both EPA and ARB have adopted exhaust emission standards for Tier 1Tier 4 engines. Two separate rules.	2008-2015	Port of Oakland	Cargo handling equipment	Equipment Upgrade
Ultra-low Sulfur Fuel	Require less than 15 ppm sulfur diesel fuel (EPA requires a cap of 15 ppm for non-road, phasing in 2010-2014, currently at 500 ppm.)	2006	Port of Oakland	Cargo handling equipment	Fuel upgrade
Port of Oakland Idling Trucks California Health and Safety Code Section 40720 (AB 2650 & AB 1971)	Existing law requires each marine terminal in the State to operate in a manner that does not cause the engines on trucks to idle or queue for more than 30 minutes while waiting to enter a terminal gate.	2002-2004	Port of Oakland	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
ARB Port Truck Rule	Replace/retrofit trucks to meet emission standards	2008	Port of Oakland	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
ARB Statewide Heavy-Duty (in-use) Truck Rule	Require private fleet operators to replace/retrofit diesel trucks greater than 14,000 GVWR to meet emission standards.	2008-2011	Port of Oakland	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Ultra-low Sulfur Fuel	Require less than 15 ppm sulfur diesel fuel	2006	Port of Oakland	Heavy Duty Diesel Fueled On-Road Vehicles	Fuel upgrade
Tier 3 and 4 Emission Standards for Locomotives	Additional emission standards for new and remanufactured locomotive engines. Additional emissions standards for previously remanufactured and existing locomotive engines	2008	Port of Oakland	Locomotives	BMP / Educational Policies
2005 Rail Yard Particulate Matter Reduction Program (2005 MOU)	- install idle control devices on intrastate locomotives • limit/quickly repair smoking locomotives • maximize use of low sulfur fuel • conduct Health Risk Assessments at 16 major rail yards • develop/review mitigation plans at 16 major yards • evaluate remote sensing technology • evaluate new technology	2005	Port of Oakland	Locomotives	BMP / Educational Policies
ARB intrastate locomotive low sulfur fuel rule	Requires the use of CARB fuel (less than 15 ppm sulfur) for locomotives used 90% in state (mostly switcher)	2007	Port of Oakland	Locomotives	Fuel upgrade
San Francisco Bay Area Green Ports Initiative	Initiative includes BAAQMD enforcement of ARB regulations affecting Port operations; grants for earlier or greater emission reductions; outreach; and monitoring progress.	2008	Port of Oakland	Other	BMP / Educational Policies
Employee Transit and Alternative Transportation	Enhanced transit access	Future	Port of Richmond	Other	BMP / Educational Policies
Equipment / Vehicle Replacement / Retrofit	Programs to encourage cleaner auto carrier trucks.	Future	Port of Richmond	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Exhaust Treatment Devices - evaluation and pilot	Advanced Maritime Emissions Control System (AMECS)		Port of Richmond	Ocean Going Vessels	Equipment Upgrade
Alternative Fueled Equipment / Vehicles	Replace diesel equipment with electric, hybrid, or alt. fuels	Current and future	Port of Richmond	Cargo handling equipment	Fuel upgrade
Regulatory - Fuel Sulfur requirements	CA requires use of low sulfur fuel.	2010	Port of Richmond	Ocean Going Vessels	Fuel upgrade
Regulatory - Fuel Sulfur requirements	CA requires use of low sulfur fuel.	2010	Port of Richmond	Harbor Vessels	Fuel upgrade
On-site Renewable Energy Generation	Solar panels and other renewables for Port and tenants.	Future	Port of Richmond	Other	Infrastructure Upgrade

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Shore Power	CARB regs require 50% of all container cruise and reefer vessels to use shore power by 2014.	"Future"	Port of Richmond	Ocean Going Vessels	Infrastructure Upgrade
Airborne Toxic Control Measures - Diesel Engines	CA requires for auxiliary diesel engines. Limiting operation at docks.	2006	Port of Richmond	Ocean Going Vessels	Operating Procedure Update
Vessel Speed Reduction Program	Referenced Green Flag Program at Long Beach, San Diego's VSR, and San Pedro's VSR program.	"Future"	Port of Richmond	Ocean Going Vessels	Operating Procedure Update
Operational efficiency	Berth and ship-specific feasibility, tracking mechanisms	"Future"	Port of San Diego	Ocean Going Vessels	Operating Procedure Update
Shore Power	Candidate local control measure	"Future"	Port of San Diego	Ocean Going Vessels	Infrastructure Upgrade
Vessel Speed Reduction	Candidate local control measure	"Future"	Port of San Diego	Ocean Going Vessels	Operating Procedure Update
Idling Time	Reduce idling times. Evaluation of feasibility and funding sources.	"Future"	Port of San Diego	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
Electrification of select activities	Evaluation of equipment and feasibility	"Future"	Port of San Diego	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Replacements and Retrofits	Candidate local control measure	"Future"	Port of San Diego	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Replacements and Retrofits	Candidate local control measure	"Future"	Port of San Diego	Cargo handling equipment	Equipment Upgrade
Auxiliary Engine Design	OGV's Hoteling	"Future"	Port of San Diego	Ocean Going Vessels	Equipment Upgrade
Boiler Design	OGV's Hoteling	"Future"	Port of San Diego	Ocean Going Vessels	Equipment Upgrade
After-Treatment	OGV's Hoteling/Transiting -(filtering)	"Future"	Port of San Diego	Ocean Going Vessels	Equipment Upgrade
Low-Sulfur Fuel	OGV's Hoteling/Transiting	"Future"	Port of San Diego	Ocean Going Vessels	Fuel upgrade
Operational Efficiency	OGV's Hoteling	"Future"	Port of San Diego	Ocean Going Vessels	Operating Procedure Update
Main Engine Design	OGV's Transiting.	"Future"	Port of San Diego	Ocean Going Vessels	Equipment Upgrade
Engine Design	Upgrades in engine designs.	"Future"	Port of San Diego	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Low Sulfur and Alternative fuels	Alternative fueling options.	"Future"	Port of San Diego	Heavy Duty Diesel Fueled On-Road Vehicles	Fuel upgrade
Alternative Power	No details	"Future"	Port of San Diego	Cargo handling equipment	Equipment Upgrade
Engine Design	No details	"Future"	Port of San Diego	Cargo handling equipment	Equipment Upgrade
Idling Time	No details	"Future"	Port of San Diego	Cargo handling equipment	BMP / Educational Policies
Low Sulfur and Alternative fuels	No details	"Future"	Port of San Diego	Cargo handling equipment	Fuel upgrade

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Engine Design	No details	"Future"	Port of San Diego	Harbor Vessels	Equipment Upgrade
Replacements and Retrofits	No details	"Future"	Port of San Diego	Harbor Vessels	Equipment Upgrade
Low-Sulfur Fuel	No details	"Future"	Port of San Diego	Harbor Vessels	Fuel upgrade
Engine Design	No details	"Future"	Port of San Diego	Locomotives	Equipment Upgrade
Replacements and Retrofits	No details	"Future"	Port of San Diego	Locomotives	Equipment Upgrade
Alternative Technologies	No details	"Future"	Port of San Diego	Locomotives	Equipment Upgrade
Idling Time	No details	"Future"	Port of San Diego	Locomotives	BMP / Educational Policies
Low-Sulfur Fuel	No details	"Future"	Port of San Diego	Locomotives	Fuel upgrade
Shore Power	"cold ironing", Vessels at berth plug into Port's electrical grid.	Planned	Port of Miami	Ocean Going Vessels	Infrastructure Upgrade
Crane Electrification	Retrofitting existing cranes, replacing diesel fuel.	2009-2016	Port of Miami	Cargo handling equipment	Equipment Upgrade
Purchase cranes over 25 Years old	Planning for 23 cranes by 2034	by 2034	Port of Miami	Cargo handling equipment	Equipment Upgrade
LEED Buildings	All new buildings must be LEED certified.	ongoing	Port of Miami	other	BMP / Educational Policies
Green Energy Initiatives - Tunnel	Additional means of ingress and egress through tunnel.	by 2034	Port of Miami	Other	Infrastructure Upgrade
Green Energy Initiatives - Rail Yard	Reintroducing rail service at the Port and the development of an on-Port rail yard which will help decrease traffic congestion and reduce emissions.	by 2034	Port of Miami	Locomotives	Infrastructure Upgrade
Green Energy Initiatives - Cargo gate consolidation	Consolidation of the individual tenants' cargo gates to the Port's one Security Cargo Gate complex. This project also includes creating a fast-pass lane to increase efficiency and reduce processing time at the gates.	by 2034	Port of Miami	Cargo handling equipment	Infrastructure Upgrade
Green Energy Initiatives - Wind Farm	Under consideration.	by 2034	Port of Miami	Other	Infrastructure Upgrade
Green Energy Initiatives - multi-modal center	A multimodal center allowing for the consolidation of ground transportation, decreasing the sprawled footprint of the Port, therefore allowing for increased efficiency and additional land to be dedicated to cruise or cargo business.	by 2034	Port of Miami	Other	Infrastructure Upgrade

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Clean TRIP Grant	local short-haul truck incentive to replace older models with 2011 or newer trucks.	2016	Port of New Orleans	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Southeast Louisiana Clean Fuel Partnership	USDoE - support alternative fuels and fuel saving technologies	2015	Port of New Orleans	Other	Fuel upgrade
Exhaust retrofits	Verified exhaust and crankcase emissions controls	2015	Port of New Orleans	Cargo handling equipment	Equipment Upgrade
Idle Reduction	Short lane RR switches	2015	Port of New Orleans	Locomotives	BMP / Educational Policies
Idle Reduction	Standards	2015	Port of New Orleans	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
Engine upgrade and repowers	No details	2015	Port of New Orleans	Cargo handling equipment	Equipment Upgrade
Fleet and equipment replacement	non-road newer diesel vehicles, equipment	2015	Port of New Orleans	Cargo handling equipment	Equipment Upgrade
Fleet and equipment replacement	highway diesel vehicles	2015	Port of New Orleans	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Cleaner fuels, alternative fuels	No details	2015	Port of New Orleans	Heavy Duty Diesel Fueled On-Road Vehicles	Fuel upgrade
Cleaner fuels, alternative fuels	No details	2015	Port of New Orleans	Cargo handling equipment	Fuel upgrade
Cleaner fuels, alternative fuels	No details	2015	Port of New Orleans	other	Fuel upgrade
Emission Control Area (ECA) requirements	While hoteling	2015-2020	Northwest Ports	Ocean Going Vessels	BMP / Educational Policies
Shor power use	While hoteling	2015-2020	Northwest Ports	Ocean Going Vessels	Infrastructure Upgrade
Cleaner fuels	While hoteling	2015-2020	Northwest Ports	Ocean Going Vessels	Fuel upgrade
Other Emissions reduction technologies	While hoteling	2015-2020	Northwest Ports	Ocean Going Vessels	Equipment Upgrade
Port-designated or third party certification program	promotes continuous improvement (i.e.. Ship index, green marine, clean cargo..)	2015-2020	Northwest Ports	Ocean Going Vessels	BMP / Educational Policies
Outreach and Best Management Practices	Strategy partners conduct annual outreach to port related harbor vessel companies and recognize best practices	2015-2020	Northwest Ports	Harbor Vessels	BMP / Educational Policies
Certification Program	promotes continuous improvement (i.e.. Ship index, green marine, clean cargo..)	2015-2020	Northwest Ports	Harbor Vessels	BMP / Educational Policies
CHE meets Tier 4 Interim (T4i)	Emissions standards or equivalent	2015-2020	Northwest Ports	Cargo handling equipment	BMP / Educational Policies
CHE meets Tier 4 Interim (T4i)	Emissions standards or equivalent	2015-2020	Northwest Ports	Cargo handling equipment	Equipment Upgrade
Fuel-Efficiency Plans	promote continuous improvement	2015-2020	Northwest Ports	Cargo handling equipment	BMP / Educational Policies

Program	V. brief description	Date Implemented or Planned	Port	Emissions Source	Program Type
Emissions standards	Trucks meet or surpass U.S. EPA emission standards or equivalent for model year 2007	2015-2020	Northwest Ports	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
Emissions standards	Trucks meet or surpass U.S. EPA emission standards or equivalent for model year 2007	2015-2020	Northwest Ports	Heavy Duty Diesel Fueled On-Road Vehicles	Equipment Upgrade
Fuel-Efficiency Plans	promote continuous improvement	2015-2020	Northwest Ports	Heavy Duty Diesel Fueled On-Road Vehicles	BMP / Educational Policies
Switcher participate in fuel program	owners/operators institute program	2015-2020	Northwest Ports	Locomotives	BMP / Educational Policies
Switcher replace unregulated engines	engine replacements will be Tier 2 or better	2015-2020	Northwest Ports	Locomotives	Equipment Upgrade
Construction standards	adopt policies for idle reduction, engine requirements	2015-2020	Northwest Ports	Other	BMP / Educational Policies
Energy studies and conservation projects	in building systems, operations, and yard lighting	2015-2020	Northwest Ports	other	BMP / Educational Policies
Fuel-Efficiency Plans	promote continuous improvement	2015-2020	Northwest Ports	other	BMP / Educational Policies
		2015-2020	Northwest Ports		

APPENDIX E
CALCULATED EMISSION REDUCTIONS

Emission Reduction Summary

2019 Baseline Emissions

Total Emissions (as reported in 2019 GMEI)

Inventory	NO_x (ton/yr)	$PM_{2.5}$ (ton/yr)
OGV	4120	63
HV	496	12
CHE	370	28
Locomotive	587	16
HDDV	1395	64
Total	**6967**	**182**

Emission Reduction

Total Emission Reduction

Inventory	NO_x (ton/yr)	$PM_{2.5}$ (ton/yr)
OGV (Operational Improvements)	1030	35
HV	-	-
CHE (Replace All Tier 0 and Tier 1)	33.00	2.60
Locomotive	-	-
HDDV (Operational Improvements)	362	35
HDDV (50% trucks MY 2010+)	260	14
Total	**1685.00**	**86.60**

	NO_x (ton/yr)	$PM_{2.5}$ (ton/yr)
2007 GMEI	6716	386
CASP NOX Target (25% reduction from 2007 GMEI)	5037	N/A
CASP PM2.5 Target (75% reduction from 2007 GMEI)	N/A	96.50
Reductions from CASP Measures	1685.00	289.60
Do Reductions meet Target?	5031.00	96.40

Note: The Reductions from CASP Measures for PM2.5 include the reductions from the CASP update and the reductions from 2013 to 2019 (225 tons/year)

% Reduction from 2019 Baseline

Total Reduction

Inventory	NO_x (ton/yr)	$PM_{2.5}$ (ton/yr)
OGV (Operational Improvements)	25%	56%
HV	-	-
CHE (Replace All Tier 0 and Tier 1)	8.92%	9.29%
Locomotive	-	-
HDDV (Operational Improvements)	25.95%	54.69%
HDDV (50% trucks MY 2010+)	18.64%	21.88%
Strategy 1 Emission Reductions only	4.21%	9.12%
Emission Reduction	**24.19%**	**47.58%**

Potential Tenant Reductions
(for informational purposes only)

2019 Baseline Emissions

Total Emissions (as reported in 2019 GMEI)

Inventory	NO_x (ton/yr)	$PM_{2.5}$ (ton/yr)
OGV	4120	63
HV	496	12
CHE	370	28
Locomotive	587	16
HHDV	1395	64
Total	**6967**	**182**

Emission Reduction

Inventory	NO_x (ton/yr)	$PM_{2.5}$ (ton/yr)
OGV	-	-
HV	-	-
CHE (Replace All Tier 0 and Tier 1)	59.00	4.60
Locomotive	-	-
HDDV (50% trucks MY 2010+)	20.00	1.00
Total	**79.00**	**5.60**

% Reduction from 2019 Baseline

Inventory	NO_x (ton/yr)	$PM_{2.5}$ (ton/yr)
Ocean Going Vessels	-	-
Harbor Vessels	-	-
Cargo Handling Equipment	15.95%	16.43%
Locomotive	-	-
Heavy Duty Diesel Trucks	1.43%	1.56%
Emission Reduction	1%	3%

Port Houston
CASP Emission Reductions for CHE
Replace older equipment with Tier 4 equipment

Total count and emission reductions for both port owned and tenant T0 & T1 CHE once replaced to T4

Equipment owner	T0 & T1 CHE Count	NOx emission reduction	PM2.5 emission reduction
Port owned	60	33.0	2.6
Tenant	191	59.0	4.6
Total count and reductions	**251**	**92.1**	**7.2**
Percent of total CHE emissions		**25%**	**26%**

Scenario Replacing all T0 and T1 PHA owned CHE w T4

Scenario 2	T0 & T1 CHE Count	NOx emission reduction	PM2.5 emission reduction
Replace all T0 and T1 PHA owned	60	33.0	2.6
Percent of Total CHE emissions		**9%**	**9%**

Scenario Replacing all T0 and T1 tenant CHE w T4

Scenario 4 - Replacing all T0 and T1 tenant CHE	T0 & T1 CHE Count	NOx emission reduction	PM2.5 emission reduction
Replace all of T0 and T1 tenant CHE	191	59.0	4.6
Percent of Total CHE emissions		**16%**	**16%**

Port Houston
2021 CASP
Emission Reductions - Locomotives

2027 scenario: Replace PTRA locomotives with Tier 4 locomotives

Emissions, tons per year (based on 2019 activity)

Tier Level	NO_x	PM_{10}	PM_{25}
Pre-tier	14.7	0.4	0.4
Tier 0	56.7	2.1	2.1
Totals	**71.4**	**2.5**	**2.5**
Tier 4	5.4	0.09	0.09

Reductions	NO_x	PM_{25}
Reductions, tpy	66.1	2.4
2019 GMEI Locomotive	587	16
% Reduction	11%	15%

Calculations below:

From 2019 EI Tier Level	Hours	Fuel gallons	Horsepower -hours
Pre-tier	7,700	53,900	819,280
Tier 0	40,970	286,790	4,359,208
Totals	48,670	340,690	5,178,488

Fuel consumption rate: 7 gal/hr (PTRA)
HP-hr per gallon:: 15.2 hphr/gal (EPA)

Switching emission factors, g/hphr

Tier Level	NO_x	PM_{10}	PM_{25}
Pre-tier	16.3	0.44	0.43
Tier 0	11.8	0.44	0.43
Tier 4	0.94	0.015	0.015

EF Source: Office of Transportation and Air Quality EPA-420-F-09-025 April 2009

TxLED = 6.2% NOx reduction	
Base EF:	
Pre-tier	17.4
Tier 0	12.6
Tier 4	1.0

Port Houston
Emission Reductions - HDDVs

CY 2026 scenarios

Scenario 1/2 Replace 50% of 2009 and older with 2010 and newer
Assumed an even model year distribution of replacement 2010 and newer trucks

Emissions and reductions are based on 2019 activity levels, 2026 EFs and projected MY distribution

	Baseline		Scenario1/2	
	NO_x	$PM_{2.5}$	NO_x	$PM_{2.5}$
Reductions from baseline, tpy in 2027				
BCCT, BCT, TBT	0	0	260	14
Others	0	0	20	1

Calculations below:

2027 emission factors		
	Composite EFs	
	NOx	**PM2.5**
Baseline g/mi		
Container	7.25	0.266
Non-container	7.98	0.313	
Scenario 1/2		
Container	5.17	0.150
Non-container	5.45	0.173

Terminal	**Miles*** (round trips)	**Baseline** NO_x	**Baseline** $PM_{2.5}$	**Scenario 1/2** NO_x	**Scenario 1/2** $PM_{2.5}$
Barbours Cut Container Terminal	25,651,927	205	7.5	146	4.2
Bayport Container Terminal	64,798,066	518	19.0	369	10.7
Turning Basin Terminal	19,054,217	168	6.6	114	3.6
Total	**109,504,210**	**891**	**33.1**	**630**	**18.6**
Bayport Auto Terminal	397,641	3	0.1	2	0.1
Bulk Materials Handling Plant	853,181	8	0.3	5	0.2
Care Terminal	991,247	9	0.3	6	0.2
Jacintoport Terminal	4,103,055	36	1.4	25	0.8
Woodhouse	768,590	7	0.3	5	0.1
Total	**7,113,714**	**63**	**2.5**	**43**	**1.4**

Port Houston
Harbor Craft Reductions for CASP

Calculate control factor

	main NOx CF	main PM2.5 CF	
T4/T0	0.12	0.18	T4/T0

Towboat and Tug Boats Engines (Propulsion and Aux)

	NOx tons	**PM2.5 tons**	TxLED Adjusted
Towboat and Tug Boats Propulsion and Aux Engine	486	11	
Tug/tow T0 emissions %	79%	70%	from AIS/IHS Based emissions calc
Total tug/tow emissions are T0	386	8	
take 20% of T0 emissions	77	2	
reduce 20% T0 to Tier 4 emissions	9	0	
emissions reduced	68	1	
Scenario tug/tow emissions	418	10	
2019 Harbor Vessel	496	12	
Emissions Reduction %	**14%**	**11%**	